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China: **Land of Famine.** By WALTER H. MALLORY. With a Foreword by DR. JOHN H. FINLEY, President of the American Geographical Society. With 91 photographs and 12 maps. xvi and 199 pp. *Special Publication No. 6.* 1926. $4.00.

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Oriental Explorations and Studies, Nos. 1–6. By ALOIS MUSIL. No. 1. **The Northern Ḥeǧâz: A Topographical Itinerary.** xii and 374 pp. 1926. $7.00; No. 2. **Arabia Deserta: A Topographical Itinerary.** xvii and 631 pp. 1927. $8.00; No. 3. **The Middle Euphrates: A Topographical Itinerary.** xv and 426 pp. 1927. $8.00; No. 4. **Palmyrena: A Topographical Itinerary.** xiv and 367 pp. 1928. $7.00; No. 5. **Northern Neǧd: A Topographical Itinerary.** xiii and 368 pp. 1928. $7.00; No. 6. **The Manners and Customs of the Rwala Bedouins.** xiv and 712 pp. 1928. $8.00. Each volume fully illustrated with photographs, maps, drawings, and plans.

Map of Hispanic America, 1:1,000,000 [15.78 miles to 1 inch], Provisional Edition. 42 sheets of this map have now been published. An index map to the sheets may be obtained upon request. $2.00 each sheet.

The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps. viii and 90 pp. *Library Series No. 4.* 1927. $15.00 ($2.00 for text alone).

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XXII JULY, 1932 NO. 3

SECTIONS AND NATIONAL GROWTH

AN ATLAS OF THE HISTORICAL GEOGRAPHY OF THE UNITED STATES*

John K. Wright

[With separate map, Pl. II, facing p. 360]

THE election returns next November will record the political preferences of the American people by districts and wards, townships and counties, cities and states. When mapped, the results of the vote will form a pattern distinctive of 1932, but this pattern will probably conform in some of its broader outlines—and even in points of detail—with the patterns on maps of earlier Presidential elections (see Fig. 9, Pl. II). As the late Professor F. J. Turner observed, such maps "disclose the fact that there are both interstate and intrastate party areas persisting in some cases for many decades or even generations and having clear relations to natural geographic factors."[1]

The foreigner is tempted to forget that the motto of the United States is *E pluribus unum* and to think of this country as a patch of solid color labeled "United States." He usually fails to visualize the black belt in the South, the manufacturing Northeast, the widely scattered agglomerations of settlement in the West, the political diversities associated with these fundamental regional differences. The politics and the policies of the United States are deeply rooted in the nation's regional composition. Figures 6 and 7, for example, show the division of opinion on two tariff measures as recorded by Congressional Districts in votes of the House of Representatives.

* C. O. Paullin: Atlas of the Historical Geography of the United States, published jointly by the Carnegie Institution of Washington and the American Geographical Society of New York. xiv and 145 pp.; 166 plates; index. New York, 1932.

[1] F. J. Turner: Geographical Influences in American Political History, *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 591–595; reference on p. 591.

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Both measures were highly protective—one the so-called "Tariff of Abominations" of 1828, the other the Smoot-Hawley Tariff of 1930. In 1930 and a century earlier the South as a block was bitterly opposed to legislation thought to benefit the Northern manufacturer at the expense of the Southern exporter of raw materials.

Many of the essentials entering into the regional composition of our country are made clear in Dr. Charles O. Paullin's "Atlas of the Historical Geography of the United States," published this summer by the Carnegie Institution of Washington and the American Geographical Society. One of the most comprehensive historical atlases that have ever been produced for a single nation, this volume, through its clean-cut and simple maps, gives a graphic concept of how the United States has gradually grown and changed and become more complex since the time of earliest settlement.

The Enigma of the United States

In many respects our history reflects our European origins. The blood in the veins of nearly nine-tenths of the American people came ultimately from Europe. We speak English; we use the English jury system in our courts; our methods of party government are largely an inheritance from England; our ideals of religious liberty and most of our religious denominations were brought from over the Atlantic. The roots of our institutions and habits of mind may be traced back directly to European sources. Yet we are not European. Nearly everything that has come to us from the Old World has undergone a subtle but profound transformation amid a new environment. This, perhaps, is why political and social movements in the United States often present an enigma to the European observer.

Natural Environment and the Frontier

The "Atlas" opens with a series of plates illustrating this new environment, this world of nature in which the American nation came into being: relief, physiography, soils, vegetation, climate, mineral resources. Figure 1, Plate II, is reproduced from one of these maps. Here, according to a widely accepted scheme, North America and a large part of the Old World are subdivided into natural regions. Within the United States there is found nearly every environmental type represented in Europe and north Africa: dry zones comparable to those of the Sahara, steppes like the steppes of Russia, forests like the forests of central, northern, and western Europe, regions of thick-leaved vegetation like that of the Mediterranean borderlands. On such a varied base of physical features and amidst climates of equal diversity a great nation has arisen and grown to maturity within the short period of three hundred years. In Europe the foundations of

national life were laid far back in the Middle Ages or earlier, but we are still close to our beginnings. The chronicle of physical expansion is a large part of our record—the story of the frontier and of the evolution of the tangible, material elements of civilization in the areas behind the frontier.

Even now there are isolated pioneer communities in parts of the United States. The older generation can look back to the time when the frontier line had not yet reached the dry West and when free lands beyond the frontier beckoned many a family away from irksome or intolerable social and economic pressures. The frontier still lives in our memories, and the frontier spirit still prompts some of our actions. It is appropriate, therefore, that stress should be laid in the "Atlas" upon the frontier and circumstances associated with it: the exploration and charting of mountains, rivers, lakes, and plains; colonization spreading into vacant lands; friendly and hostile contacts between settlers and Indians; the progress of settlement as it was fostered here and thwarted there by the great realities of nature; the use made of natural resources; the apportioning of land among individuals; the adjustment of conflicting political claims to territory; and the marking out of new administrative units. Extensive sections of the "Atlas" dealing with the Natural Environment, Cartography (1492–1867), Explorers' Routes, Indians, Settlement and Population, Lands, and Boundary Disputes illustrate these topics.

Material Expansion

While the frontier line was marching westward, behind it fields were being plowed and orchards planted; cities were being laid out; roads, canals, and railroads were extending in ever more closely woven networks; blast furnaces and smelters and factories were springing up. These "essential facts" of human geography "by which man's activity is written upon the earth's skin"—to use an expression of Jean Brunhes—were developing along very different lines in different parts of the country. How great were the differences is revealed in the "Atlas." A map for 1810 shows that cotton spinning was concentrated almost wholly in New England; the subsequent spread of the industry to other regions can be traced. In 1880 New England was still in the lead, but on the map for 1926 the dots representing cotton spindles are most densely clustered on the Piedmont belt of the Carolinas and Georgia. We can follow the flooding and ebbing tides of agricultural land utilization region by region from before the Civil War to the present: the westward expansion of improved land during the eighties, accompanying the push of settlers into the arid western parts of Kansas, Nebraska, and Texas; the recession in the lean decade that followed; the opening up of irrigated lands in the Far West; the falling into

disuse within the last twenty years of great areas of farm land in the South and the Middle West as well as in New England. Not only these large movements but characteristic details are suggested on special maps of local areas: the small-scale patchwork of landholdings typical of New England, the wide plantations of the South; western ranges and mining settlements; the narrow, winding streets of early Boston and New York; the rectangular layout of the prairie cities and countryside.

Sectionalism

The diversity of the material elements of our civilization finds its counterpart in an even greater diversity among the intangibles: racial traits, institutions, religious beliefs, educational and cultural standards, social policies, economic and political issues. A superficial appearance of uniformity resulting from our single language and the standardization of certain of our manners has been much stressed of late, particularly by foreign visitors; but below the surface physical circumstance, interests, and sentiments set our people wide apart. If the frontier has passed, sectionalism will remain as a dominant factor in the national life. It will remain, perhaps, as long as men live on this continent, for sectionalism is rooted both in human nature and in the nature of the land itself. While we are not unique among nations in exhibiting sectional cleavages—the electoral returns in Great Britain, 1885–1910, show a similar diversity of habits of mind and judgment region by region[2]—our sectionalism is distinctive because its scale is vast. In their "complexity and interplay" Professor Turner has compared the larger sections of the United States to whole European nations.[3]

The "Solid South"

The South has probably been the most definite and individualistic of our sections. Figures 2 and 3 show cotton and tobacco production in 1859; Figures 4 and 5, the distribution of slaves in 1860 and of colored persons in 1930. The slavery map is from a series on which there is shown the advance of slave-holding from Virginia and the Carolinas southwestward into the Gulf States. The outlines formed by the dots on the maps for cotton and tobacco and the solid black areas on the slavery map for 1860 closely correspond. Today the descendants of slaves still work in the cotton and tobacco fields; and atlas maps for 1924, when compared with the map for colored population in 1930, show that the areas where these crops are produced are the areas having the highest ratio of negroes in the total population.

[2] Edward Krehbiel: Geographic Influences in British Elections, *Geogr. Rev.*, Vol. 2, 1916, pp. 419–432.

[3] F. J. Turner: The Significance of the Section in American History, *Wisconsin Mag. of Hist.*, Vol. 8, 1925, pp. 255–280.

Out of this economic system based on colored labor grew distinctive social forms and political interests. The line marked off approximately by the landward edge of the shaded areas on Figure 4—the line, that is, roughly defining the limits of slavery in 1860—is unquestionably the deepest of the many lines of cleavage that cut through the structure of the nation. We have within our borders no *irredentas*, no frontiers of language and nationality along which there is now much danger of a separation. Our closest counterpart is the line between North and South—a line that once came perilously near widening into a permanent rift.

Other maps in the "Atlas" further illustrate the solidarity of the South. Attention has already been directed to Figures 6 and 7, taken from a group of maps showing the votes in the national House of Representatives on thirty-six important measures. Figures 8 and 9 are selected from a series illustrating the votes at every Presidential election. Each county, so far as returns are available, is colored according to the candidate who received a majority. In the election of 1840 little evidence is seen of the "Solid South." While all of South Carolina returned Democratic majorities, many counties scattered through the other southern states returned majorities for Harrison, the Whig candidate. Indeed, in Georgia, Alabama, and the lower Mississippi Valley Harrison appears generally to have won where the ratio of slaves was the highest (Fig. 4). After the Civil War and the "carpetbag" period Southern party loyalty became more set. Even for the election of 1928, when several of the Southern states were carried by Hoover, the map shows a wide band of Democratic territory—broken across only in North Carolina—following the coastal plain all the way from northern Virginia to southern Texas and projecting as a wide embayment up the Mississippi Valley as far as the mouth of the Ohio. It is also to be noted that the areas that returned Democratic majorities in 1928 were almost identical with those where, in 1930, negroes constituted thirty per cent or more of the total population (Fig. 5). The Republican peninsula that penetrates far down into the Solid South is again and again repeated with shifting outlines on these election maps.

Many additional circumstances that distinguish the South are disclosed on other maps: environmental circumstances such as the wide, uniform coastal plain and the flood plain of the lower Mississippi, the rich dark soils of the cotton belt, the warm, moist summers, the long growing season; human circumstances such as the preponderance of agriculture over manufacturing, the high percentage of tenant farmers, the fewness of foreign-born, the relatively low levels per capita of wealth and of expenditures on schools, and political conservatism as evidenced, for example, by opposition to such reform movements as that of woman suffrage.

Sectionalism and Democracy

Neither of our two major parties stands for a homogeneous nation-wide group of interests. Each is split into factions representing discordant sectional and local sentiments rooted in turn in diverse economic régimes. How these régimes differ, how some of the differences have come into being, and how they have found expression in the sphere of politics are revealed on the "Atlas" maps. Here foreigners may find a partial key to the enigma of America. The often hesitant course of the federal government in meeting domestic issues and in the field of foreign policy will not seem so strange to the man who pores over the "Atlas" plates, sensing the continental sweep of our land and our resources and the continental diversity of our economic and social systems. Inconsistency and compromise are inherent in democracy, particularly in a democracy as vast and varied as ours. Thus the "Atlas," while intended primarily for the writer, teacher, and student of history, is more than a mere reference book. It gives the thoughtful reader an insight into the past and helps him toward a better understanding of the present.

Plan and Contents

In the following paragraphs the plan of the "Atlas" is briefly described and its contents summarized.

The first plan for the "Atlas" was drawn up by Professor John F. Jameson nearly thirty years ago and has been followed in its main outlines. The larger part of the work was carried out between 1913 and 1927 under the direction of Dr. Charles O. Paullin of the Division of Historical Research, Carnegie Institution of Washington. In 1929 the American Geographical Society took over the task of completing the enterprise. The Society has added certain new maps and has edited the volume and seen it through the hands of engraver and printer. The artificial boundaries limiting two broad fields of scholarship have thus been crossed in the production of the "Atlas."

The "Atlas" is a substantial folio volume measuring about 14 inches high, 11½ inches wide, and 1 inch in thickness. It contains some 400 pages, including more than 620 maps printed both in black and white and in color, an introduction, explanatory text, and an index. Good durable paper and strong binding materials have been used. Nothing, however, has been expended upon mere adornment—unessential from the scientific point of view—in order that the "Atlas" may be sold at a price within the means of scholars.

Contents

Natural Environment. The maps begin with seven plates illustrating the natural environment as a background for the study of American history. On the first plate five maps place North America in relation to the rest of the world as regards winds, ocean currents, and areas where important cultivated crops are grown; limits of continental glaciation and also natural regions as defined by Herbertson and Passarge are depicted. Nearly thirty years ago Professor Herbertson stressed the historical significance of the concept of natural regions in these terms: "The recognition of natural regions gives the historian a geographical foundation for his investigations

into the development of human society . . . By comparing the histories of the same race in two different regions, or of a succession of races in the same region, it should be possible to arrive at some knowledge of the invariable effect of a type of environment on its inhabitants, and at some estimation of the non-environmental factors" (A. J. Herbertson: The Major Natural Regions, *Geogr. Journ.*, Vol. 25, 1905, p. 309). Maps showing natural regions surely would seem to belong at the very beginning of every atlas of historical geography. The remaining maps dealing with the natural environment cover the continental United States only and show relief, physiography, soil and vegetation regions, forests at different dates, climatic elements, and mineral resources.

1492–1867. Cartography and Explorers' Routes, 1535–1852. The historical part of the "Atlas" opens with reproductions of forty-eight early maps selected to illustrate the gradual widening of geographical knowledge of North America from 1492 to 1867. They disclose how the outlines of the continent were gradually rounded out into their familiar forms and how detailed information was acquired of particular regions—such as the St. Lawrence-Great Lakes Basin, the Mississippi Valley, and the Far West. The reproductions are supplemented by three maps especially drawn for the "Atlas," on which are marked the routes of Spanish, French, and American explorers west of the Mississippi, 1535–1852.

Indians. The North America of the explorer and pioneer was not an uninhabited wilderness. The Indians were often an obstacle—at times a serious one—in the way of the advancing settler. Four maps show the locations of Indian battles, skirmishes, and massacres from 1521 to 1890, and, thereby, the progressive westward movement of the zone of Indian warfare. More peaceful contacts with the aborigines are recorded on maps covering Christian missions to the Indians 1567–1861, lands ceded by the Indians to the government 1750–1890, and Indian reservations 1740–1930. The Indians differed greatly among themselves in character, language, customs, and degree of civilization, and these differences often meant much in the relations of settlers and government to the several tribes. Hence a map is included on which are indicated the areas occupied by Indian tribes and linguistic stocks about 1650.

Lands. Except for the Indian's shadowy claims, which in the long run were easily swept aside, a boundless domain until recently lay open for governments, companies, and individuals to seize and subdivide and use. In the process divergent policies, practices, and conflicting interests arose, affecting in some degree the entire course of our history. The "Atlas" includes a wide variety of maps illustrating this broad subject of lands, viz. territorial questions of international scope, the evolution of the boundaries of colonies, states, and territories; the disposition of federal lands; the details of typical grants, surveys, divisions, and holdings. Particularly comprehensive are the maps covering international, colonial, and state boundary disputes. The lines as claimed by different parties and as finally agreed upon are marked in colors; and in the text the course of negotiations is narrated, and citations are given at length from the original documents describing the various lines.

Population and Settlement. The westward advance of the frontier and the filling up of the country behind it are treated on maps for the colonial period and on a series showing the density of population in every federal census year from 1790 through 1930. Since the latter are all based on statistics by counties and the same scheme of symbols is used consistently throughout, the maps may be directly compared with one another. They give a view of the rising and spreading tides of settlement. Other series break the tides into some of their components by showing progressive changes in the distribution of slaves, free negroes, and colored persons 1790–1930, of foreign-born 1860–1930, and of German-born, Irish-born, and Swedish and Norwegian-born 1880–1900. We may also trace the inflowing currents of immigration back to

their European sources on maps of Europe for each decade from 1831 through 1929. The distribution of cities at ten-year intervals since 1790 is shown, as well as the westward advance of the center of population.

Cultural and Religious Development. This subject is illustrated on maps showing the distribution of colleges and universities and of churches of different denominations in 1775–1776 and for various dates since the colonial period down to 1890. Standards of secondary education are suggested on maps revealing by states per capita expenditures on schools 1871–1928, and the dates of enactment of compulsory attendance laws 1852–1918.

Political Parties and Opinions; Reforms. Sufficient reference has already been made to the political maps (Presidential elections and Congressional measures). These are supplemented by a series showing by states the progress of certain great reform movements that have swept across the country: abolition, modification of property qualifications for suffrage 1775–1920, woman suffrage 1838–1920, labor legislation 1883–1931, prohibition 1845–1920.

Economic History. To the history of agriculture, manufacturing, transportation, commerce, and wealth is devoted an extensive subdivision of the "Atlas." For agriculture there is an introductory map of the agricultural regions of the United States followed by dot maps and cartograms for the period since 1839 illustrating crop production, land utilization, farm tenancy, and farm values. Two criteria were selected for mapping the general progress of manufacturing: value added by manufacture and number of employees in manufacturing cities. Value added is mapped by states and number of wage earners by cities for critical years since 1839. Besides these maps for manufacturing as a whole, there are special series for particular industries: iron and steel 1620–1908, cotton 1810–1926, and motor vehicles 1909–1927. Another series illustrates the growth of the network of transportation facilities 1774–1930; canals, navigable rivers, post roads, railroads, and airways. For the increasing value of our foreign trade there are maps for the entire period from 1701 through 1929. They show total exports and imports by colonies, states, and custom districts. Maps of the world reveal the value of American trade with different regions decade by decade since 1821. The distribution of wealth in terms of value of houses and lands, taxable property, and of all property, and also as indicated by statistics of banks and bank capital and of federal income taxes collected, is mapped for different dates since 1799.

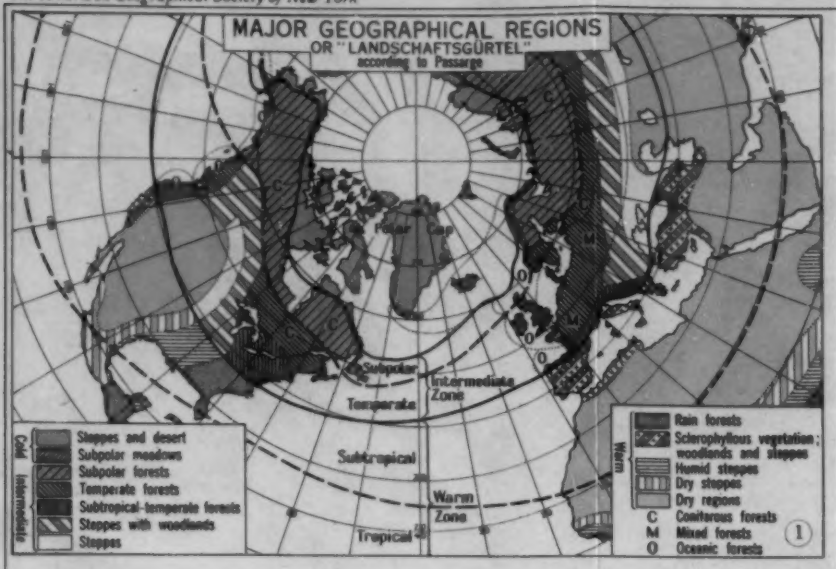
City Plans. Plans of seven of the principal cities of the United States at the close of the colonial or beginning of the national period are reproduced from contemporary documents.

Military History. The maps illustrating the colonial wars and the wars of the United States aim to make clear the progress of campaigns rather than the details of tactical maneuvers on battle fields.

The final plate is a map of the world on Mercator's projection showing outlying possessions, claims, dependencies of the United States, and also whaling grounds formerly visited by American whalers, routes followed by important American exploring expeditions, and certain points where the American army and navy have been actively engaged beyond the boundaries of the country. Thus the "Atlas" closes, as it opens, on a large theme—the United States in its world relationships.

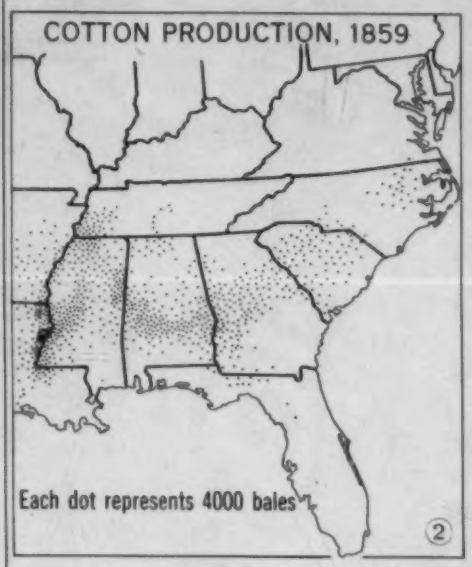
The American Geographical Society of New York

MAJOR GEOGRAPHICAL REGIONS
OR "LANDSCHAFTSGÜRTEL"
according to Passarge



① Physical Regions

COTTON PRODUCTION, 1859

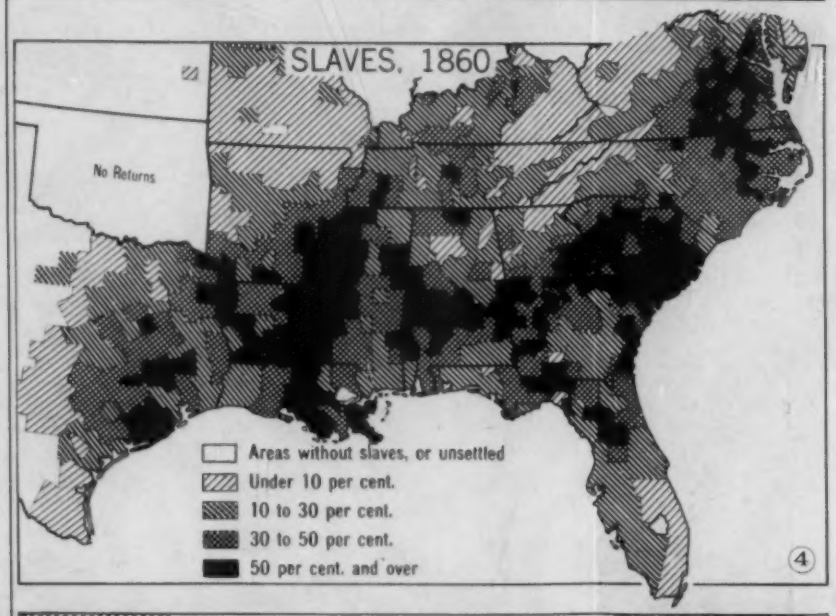


② Cotton Production

TOBACCO PRODUCTION 1859

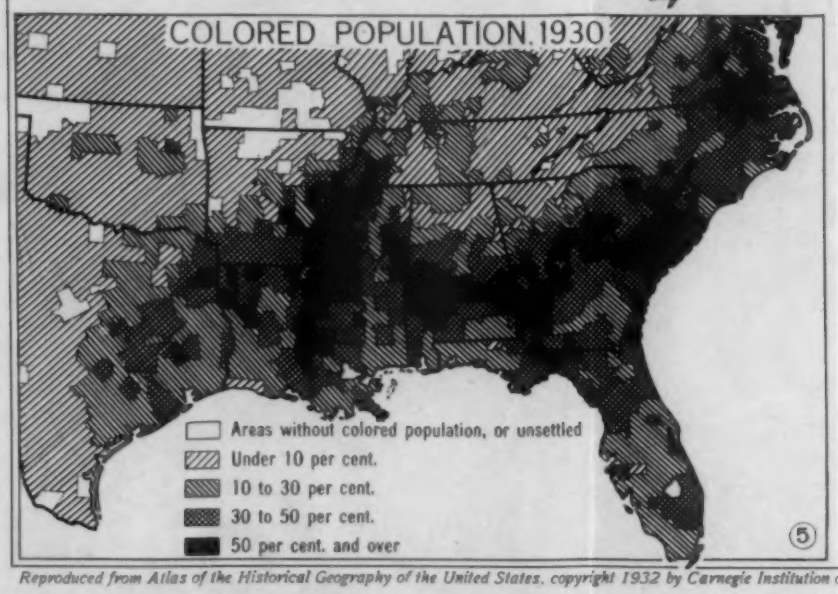
③ Tobacco Production

SLAVES, 1860



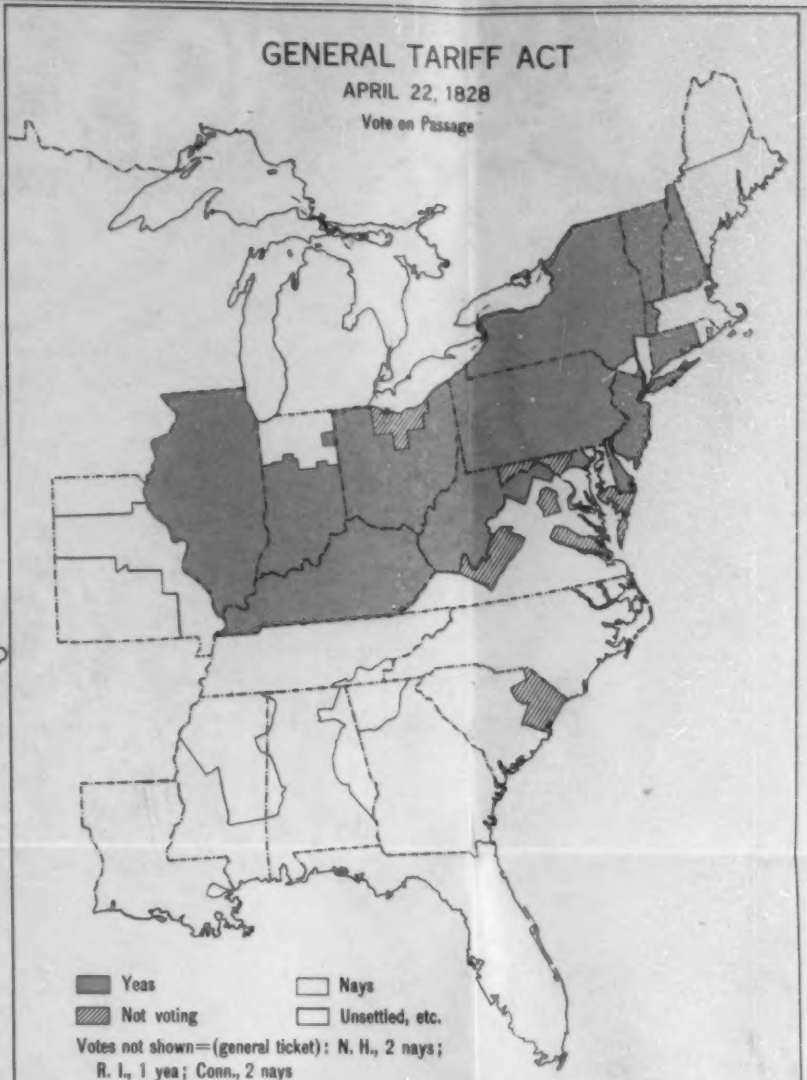
④ Slaves, 1860

COLORED POPULATION, 1930



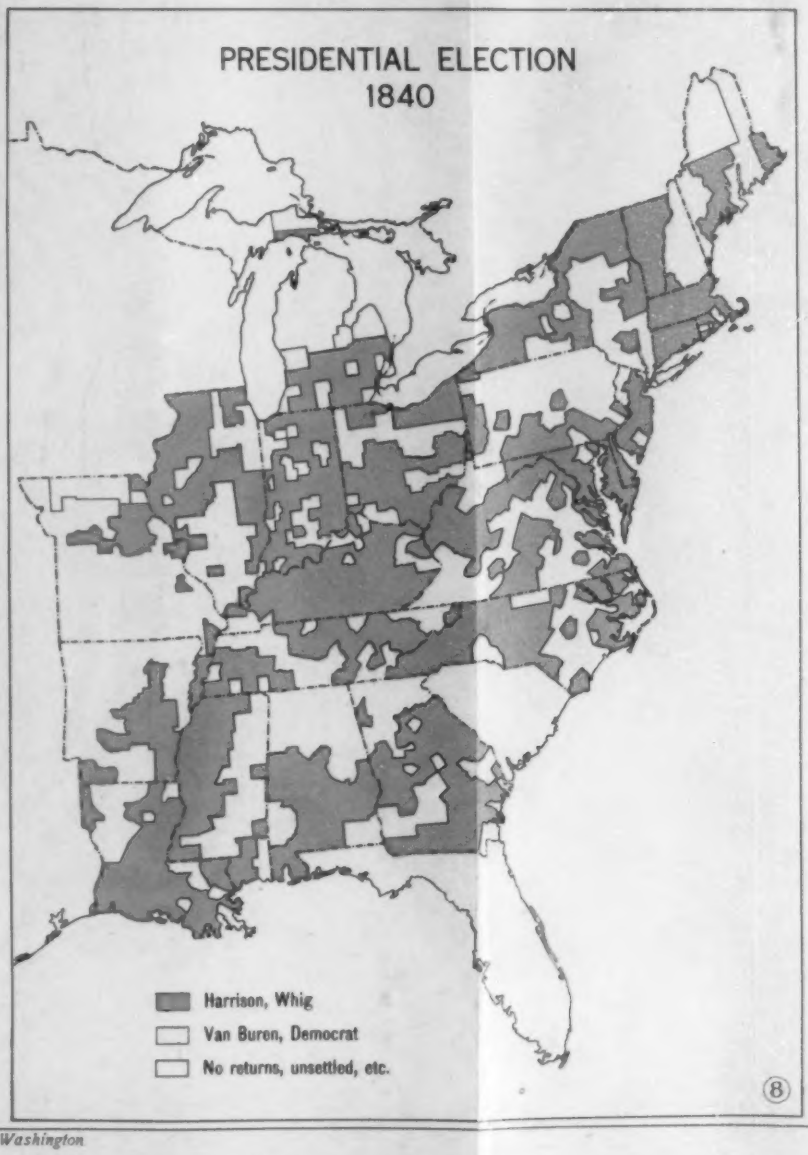
⑤ Colored Population, 1930

GENERAL TARIFF ACT
APRIL 22, 1828
Vote on Passage



⑥ General Tariff Act

PRESIDENTIAL ELECTION 1840



⑧ Presidential Election, 1840

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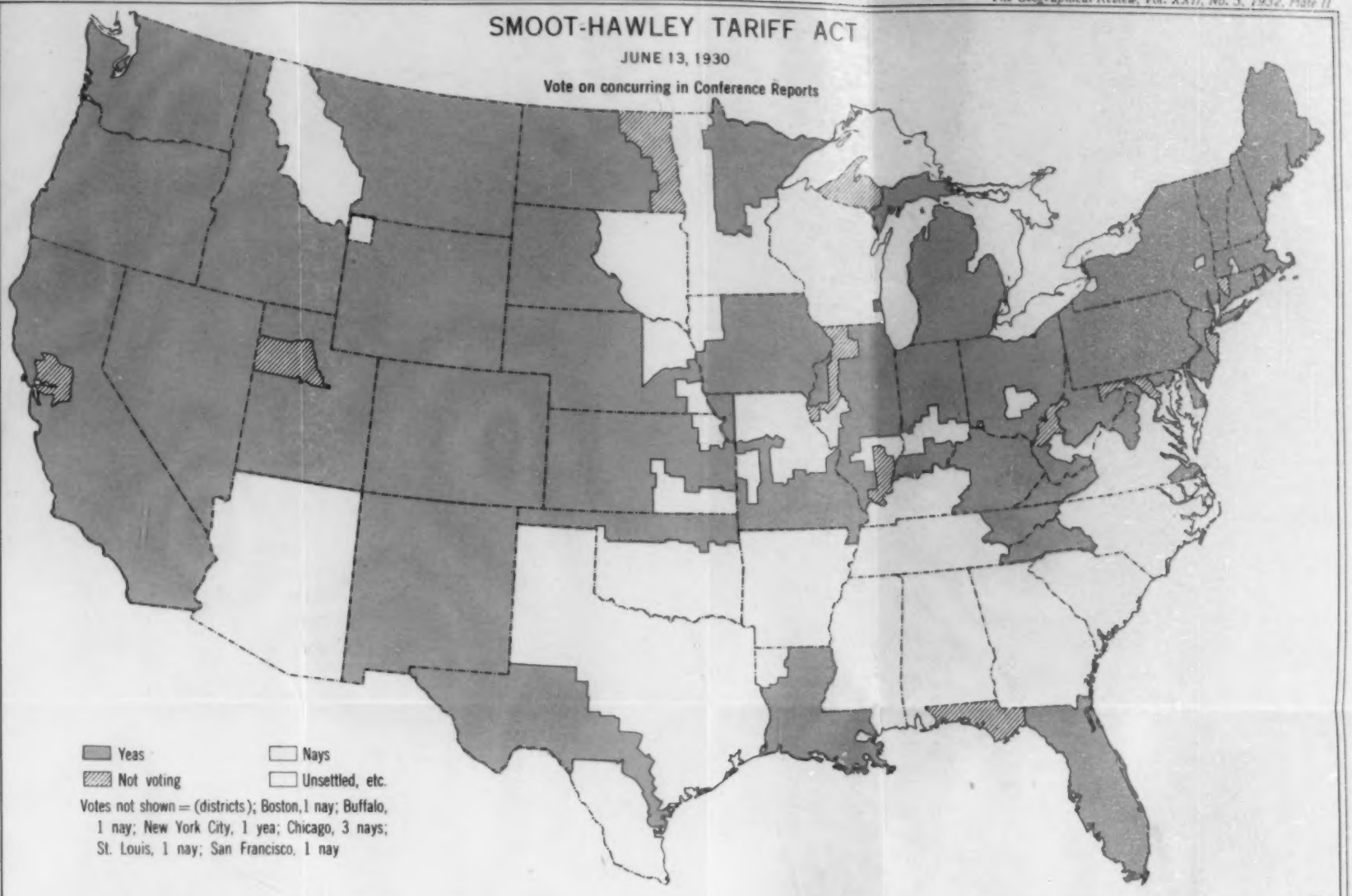
SMOOT-HAWLEY TARIFF ACT

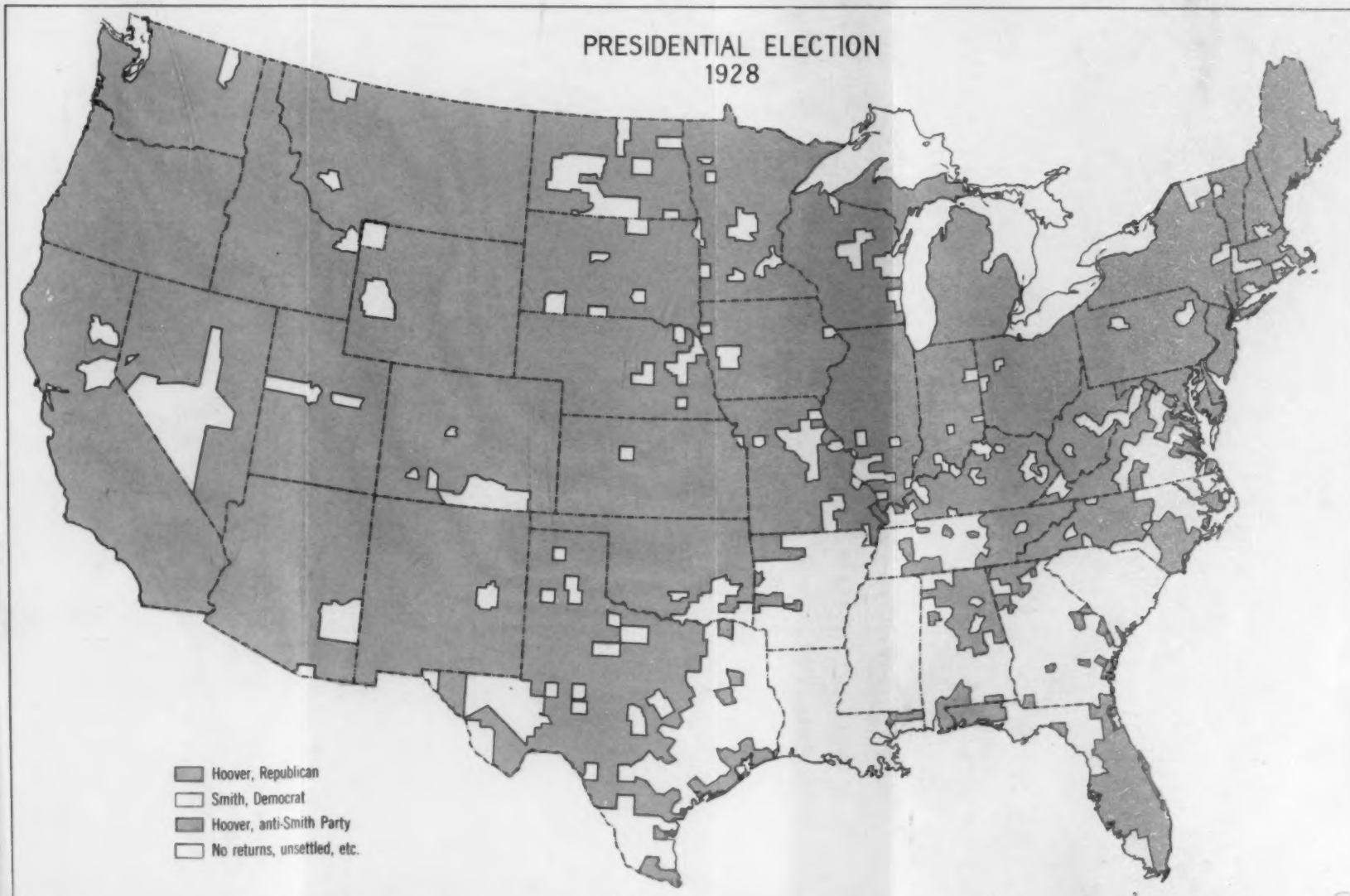
JUNE 13, 1930

Vote on concurring in Conference Reports


Yeas
Nays
Not voting
Unsettled, etc.
Votes not shown = (districts); Boston, 1 nay; Buffalo, 1 nay; New York City, 1 yea; Chicago, 3 nays; St. Louis, 1 nay; San Francisco, 1 nay

(7)

PRESIDENTIAL ELECTION
1928



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Lith. A. Hoen & Co., Inc.

THE GLACIERS OF THE NORTHERN PART OF PRINCE WILLIAM SOUND, ALASKA

William Osgood Field, Jr.

THE great ice tongues of the southern coast of Alaska are of peculiar interest to the student of glaciology, for in that region are to be found the most generally accessible glaciers that reach tidewater in the northern hemisphere. Twenty to thirty years ago these glaciers commanded the attention of several scientific expeditions but since then, except for those in southeastern Alaska, they have received comparatively little notice. The study of their behavior is, however, not only of considerable scientific interest but of economic value as well. As F. E. Matthes has recently pointed out, beyond "those far reaching considerations of a theoretical nature having to do with the broad field of climatic variations," it is "a matter of direct practical and economic import to ascertain to what manner of fluctuations the glaciers in such regions are subject."[1] For some time this has been well enough understood in the Alps where these fluctuations have been carefully recorded and analyzed, but it is only within the last year that the practical aspect of the systematized study of the North American glaciers has been officially recognized. To encourage and coördinate this study there has been formed recently a Committee on Glaciers by the Section of Hydrology of the American Geophysical Union.[2] A large part of its work is in connection with the Alaskan glaciers whose influence on certain phases of the economic life of that territory is very pronounced. As the significance of this is not generally appreciated it seems worth while to mention a few specific instances.

Some Practical Considerations

The routes to the interior of Alaska from the south that are open to year-round traffic are dominated by glaciers. Throughout the lower course of the Copper River great glaciers empty out from the side valleys and terminate on the floor of the main valley, in places partially obstructing the course of the river. Between 1906 and 1910 the Copper River & Northwestern Railway was built up this valley

[1] F. E. Matthes: Glacier-Measurements in the United States, *Trans. Twelfth Annual Meeting, Amer. Geophys. Union, April 30 and May 1, 1931*, Washington, 1931, pp. 211–215.

[2] O. E. Meinzer: Formation of the Section of Hydrology of the American Geophysical Union, *Trans. Twelfth Annual Meeting Amer. Geophys. Union, April 30 and May 1, 1931*, Washington, 1931, pp. 227–229.

American Geophysical Union, Section of Hydrology, Preliminary Announcement, Feb. 23, 1932.

FIG. 1—Panoramic view of part of the western side of Harriman Fiord from Photo Station D. At the extreme left is Cataract Glacier, next is the tidal front of Surprise Glacier. In the left center is Mt. Muir (7640 ft.) with Baker Glacier flowing from its face toward the left.

FIG. 2—The terminus of Columbia Glacier from the summit of Heather Island, Photo Station H, looking north. At the left is the main ice cliff. In the background are peaks of the Chugach Range, the highest visible the snow peak in left center (11,620 ft.).

FIG. 4—Panoramic view of the cascading glaciers on the west side of College Fiord from Photo Station O. Wellesley, next Vassar.

FIG. 1 (contd.)—In the center is Serpentine Glacier and above it a pass leading across the range to the northward-flowing Knik Glacier. The next high peak to the right is Mt. Gilbert (9550 ft.), the highest summit of this part of the Chugach Range. At the extreme right are Barry Arm and Coxe Glacier.

FIG. 3—The main ice cliff of Columbia Glacier two and one half miles long and 200 to 250 feet high. The water at the ice front attains a depth of 500 feet. Notice the small boat near the ice cliff at the right. Photograph from Photo Station G.

FIG. 4 (contd.)—Then come Bryn Mawr and Smith glaciers. The mountains at the back are from 8000 to 10,600 feet high.

FIG. 5—The ice front of Harriman Glacier. In the foreground at the base of the ice cliff is a push moraine being plowed up by the advancing terminus. It has already partially dammed the small marginal stream.

from the town of Cordova on the coast to the mines near Kennecott. En route it passes directly between the active ice cliffs of Miles and Childs glaciers crossing the Copper River at this point by a bridge erected at the cost of a million and a half dollars. During its construction both glaciers began an advance that did not cease until the ice fronts had reduced the distance separating them by over one-third and the Childs Glacier had reached a point less than 1500 feet from the bridge. That these glaciers have completely filled the floor of the valley in the recent historical past is suggested by the physiographic evidence and by a native tradition to the effect that the two glaciers were once joined.[3] An old Russian map[4] also intimates that this condition may have prevailed in the last century.

[3] W. R. Abercrombie: Report of a Supplementary Expedition into the Copper River Valley, Alaska, 1884, in "Compilation of Narratives of Exploration in Alaska," Government Printing Office, Washington, 1900, pp. 381–408; reference on p. 390.

[4] Map issued at St. Petersburg, Russia, in 1802 and reproduced in the British Atlas of the Alaskan Boundary Tribunal, Washington, 1904, map No. 5.

FIG. 6—Mt. Muir rising 7640 feet or nearly one and a half miles above Harriman Fiord. To the left is the small Baker Glacier, to the right the terminus of Serpentine Glacier.

Another vivid example is furnished a short distance above this point where it was necessary to construct five miles of road bed actually on the ice of Allen Glacier. The danger of an advance sufficiently strong to disrupt railroad traffic was apprehended in 1912 when the glacier was observed to be advancing. Fortunately, however, this advance was short-lived and did not communicate appreciable motion to the stagnant ice on which the track rested.

Fifty miles northwest of the Copper River is Thompson Pass through which now runs the only automobile highway connecting the coast with the interior. Here again are glaciers perched on the mountain sides or issuing from the tributary valleys on either side of the highway. An advance is always possible; but, whether this occurs or not, the danger of washouts is ever present in the valley below. The same condition prevails one hundred and fifty miles to the north where the highway crosses the Alaska Range.

The next pass to the west is formed by a deep valley cutting through

FIG. 7

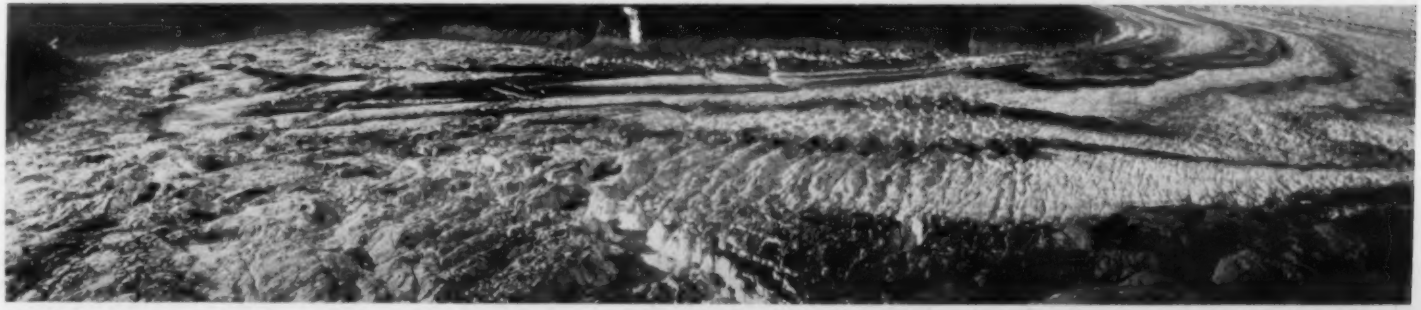

FIG. 8

FIG. 7—Upper part of Columbia Glacier showing the peaks and ice-filled valleys of the Chugach Range. View northwest from a pass on the ridge separating Shoup and Columbia glaciers.

FIG. 8—View into the large embayment on the west side of Columbia Glacier showing a portion of the ice stream at the right being deflected into the enclosed basin where it stagnates and melts away. Notice the high-water mark along the shore line and the peculiar formation of the moraines at the extreme right.

FIG. 9

FIG. 10

FIG. 9—Shoup Glacier flowing from snow fields at the left to Shoup Bay and Port Valdez, seen in the distance. The ice stream performs a right angle turn in the lower three miles of its course.

FIG. 10—Valdez Glacier showing the low sloping front characteristic of a land terminus. In 1898 and subsequent years this glacier was used as a highway by thousands of prospectors on their way across the mountains to the gold fields of the interior.

the coastal range at the head of Passage Canal. Early accounts tell of an easy route through this valley used by natives and Russians prior to 1794.[5] By 1880, however, a glacier had advanced and completely filled a part of this valley closing it to all heavy commercial traffic. In 1913, when a government railroad to the Yukon Valley was being discussed, plans were worked out for a route through this pass that was to avoid the glacier by means of a two mile tunnel. The plan, however, was later abandoned, and the next possible pass to the westward was decided upon. The tracks of the Alaska Northern Railway had already been laid over this other route and were taken over by the new enterprise, but again the nearness of glaciers was and still is a serious problem.[6] Several ice tongues, among the best known of which are the Spencer and Bartlett glaciers, come within a quarter of a mile of the track in such a way that by floods or by advances of their termini they can totally disrupt railroad traffic.

That the possibility of destructive advances by Alaskan glaciers really exists in such localities as those just mentioned is suggested by a few special cases: From July 6, 1906, to July 10, 1909, Tarr and Martin report that Hidden Glacier in the Yakutat Bay region "pushed its front forward fully two miles." In the 1909 advance of Childs Glacier, referred to above, the ice front came forward nearly 2000 feet in two years, at times moving ahead three feet a day. Logan Glacier, north of Mt. St. Elias, advanced in 1912 after at least two hundred years of inactivity; and the Grand Pacific Glacier in Glacier Bay advanced about 4000 feet between August, 1912, and September, 1913.

Influence on Mining

Present-day glaciation also exerts an influence over the productivity of certain mining areas. Back of Prince William Sound is a gold and copper producing area. Where the deposits occur near the water's edge they have been mined with considerable success; but in the mountains, where nearly all the valleys are filled with glaciers, difficulties are vastly increased. One mine was run for several years on a nunatak on Columbia Glacier eighteen miles above its terminus.[7] It was reached from a neighboring valley by a route leading ten miles over glaciers and snow fields and in one place crossing a pass 4400 feet high. Machinery, building materials, and various mining tools were hauled to the mine, and a telephone was set up. One winter the bunk house was destroyed by an avalanche and the telephone system broke down. Later on the gold bearing vein was lost under

[5] Captain George Vancouver: A Voyage of Discovery to the North Pacific Ocean, and Round the World, London, 1801, Vol. 5, pp. 249–250, 288, and 306–311.

[6] R. S. Tarr and Lawrence Martin: An Effort to Control a Glacial Stream, *Annals Assn. of Amer. Geogrs.*, Vol. 2, 1912, pp. 25–40.

[7] B. L. Johnson: The Gold and Copper Deposits of the Port Valdez District, *U. S. Geol. Survey Bull. 622*, Washington, 1915, pp. 140–188; reference on p. 183.

the glacier with the result that after only a few seasons work the whole project had to be abandoned. Some mines were also developed along the margins of Valdez Glacier, and for some years a considerable amount of gold was extracted. Later, however, these were forced to shut down owing to the natural difficulties involved, not the least of which was the gradual lowering of the glacier surface through shrinkage which in at least one instance cut off all access to the mining property.[8] In another case a road to a copper mine that followed the edge of Columbia Glacier and crossed from the neighboring mountain side onto the ice became impassable when the ice surface was lowered and left exposed a bare rock cliff between itself and the continuation of the road on the land. Another claim is said to have been covered up by an advance of Harriman Glacier between the time it was established and the arrival, several months later, of the machinery and equipment necessary to develop it.

Many of these difficulties with mining operations have been directly due to inadequate knowledge of the possible and even probable behavior of the glaciers involved. Lack of attention to such details has also caused serious mistakes in railroad engineering. A case in point was the laying of the rails of the Alaska Northern so close to the terminus of Spencer Glacier that within a few years they were wrecked by the shifting streams that issued from the glacier. In this instance a much safer route could originally have been followed in laying out the track. In the case of the Copper River Railway the route selected seems to have been the best available. As yet no ice advance has destroyed the track, but there has been frequent trouble from washouts directly attributable to the near-by glaciers. Most of the washouts seem to be due to the torrential discharge occasioned by the breaking out of glacial lakes—a phenomenon which, with adequate study, could probably be charted with considerable accuracy. Other forms of washouts occur as seen by the writer in 1931 when the drainage stream from Allen Glacier on the Copper River suddenly shifted its course by breaking through a barrier of stagnant ice and did considerable damage to the track and roadbed seven miles from where its former course was bridged. Had there been an opportunity of making frequent inspections of this portion of the glacier it is reasonable to say that this occurrence could have been foreseen.

Varied Behavior of Glaciers

The need of definite observations and increased data with regard to the behavior of the Alaskan glaciers individually and by districts is apparent if one considers that glaciers of different sections have behaved differently within the last few hundred years—a phenomenon

[8] Information from Chris Peterson and other residents of Valdez.

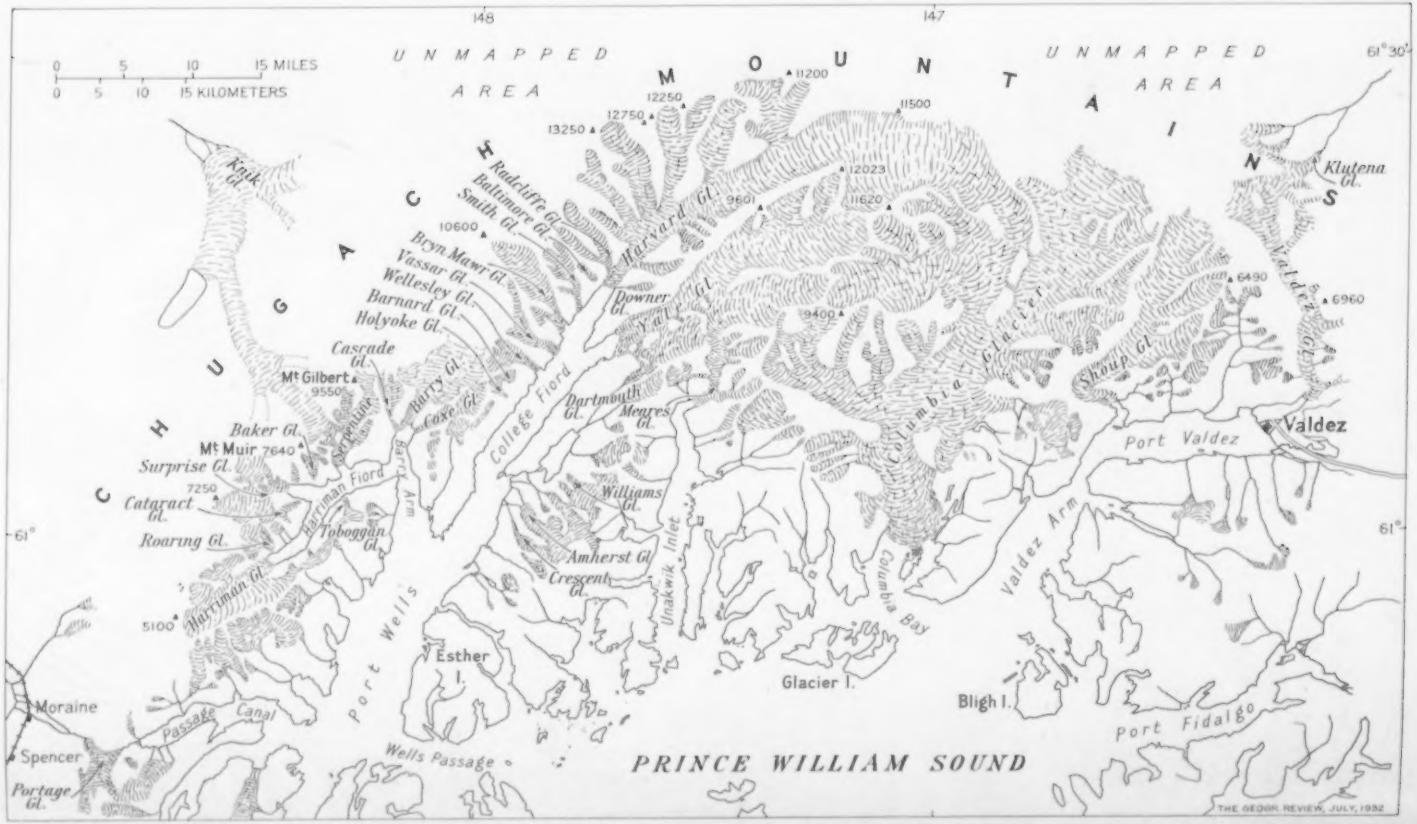

FIG. 11—Map of the northern part of Prince William Sound, and a portion of the Chugach Range, Alaska. Many of the topographic features indicated will be subject to modification in the future when more detailed maps can be made of the region. The principal sources for this map are: (1) Reconnaissance Map, Alaska Railroad, Seward to Matanuska Coal Field, scale 1:250,000 U. S. Geological Survey, 1924; (2) Valdez and Vicinity, Sheet No. 602 F, scale 1:62,500, U. S. Geological Survey, 1930; (3) Map of Copper River District, scale, 1 : 500,000, Alaska Road Commission, 1929; topographic sketch map of Harvard Glacier and tributaries by Dora Keen, 1917; (4) observations by the author, 1931.

not observed as clearly or on such a large scale in any other part of the world. For instance, in Glacier Bay in southeastern Alaska there is conclusive proof that a maximum in the eighteenth century followed a long period during which the glaciers covered a more restricted area than they do today and that since the maximum the glacier fronts have retreated fifty-five miles and the volume of ice has correspondingly shrunk.[9] On the other hand, a few miles away at Lituya Bay there has been an advance since La Pérouse visited that locality in 1786. Farther along the coast at Yakutat Bay there has been a widespread retreat during the last century, and this also seems to be the case for the glaciers of the Copper River. Yet to the northwest in Prince William Sound many of the ice fronts are farther advanced today than they have been for at least the greater part of a century. In addition to these general differences it must be remembered that within each district certain glaciers experience minor fluctuations which, though they are usually temporary, are nevertheless at complete variance with the general behavior of the other glaciers.

Pending the systematic collection of data a single set of observations has value provided that it is properly correlated and made available for future studies in that locality. Such a set of observations is here presented for the glaciers in the district lying to the north of Prince William Sound where rises the little-known Chugach Range stretching in a great arc from the St. Elias Mountains on the southeast to the mountains of the Kenai Peninsula on the west. Much of the mountainous area within this range is unmapped and unexplored, and the upper reaches of most of the large glaciers are as yet unknown. Directly north of the sound are the highest elevations culminating in a superb snow peak, 13,250 feet high, situated only eleven miles from tidewater. On each side, but more especially to the east, rise peaks of over 10,000 feet, with all the intervening valleys completely filled by glaciers and snow fields. At several places deep fiords penetrate the heart of the range—notably at Harriman and College fiords and Unakwik Inlet where the mountains rise abruptly from the sea and provide glacier and fiord scenery that can scarcely be surpassed. Here dense forests close to the ice fronts add greatly to the beauty of the whole district.

The glaciers of this section have not as a whole greatly varied in extent during the past thirty-five years, but nevertheless there have been some notable changes and many minor oscillations of the ice fronts. The first careful studies were made by G. K. Gilbert, a member of the Harriman Alaska Expedition of 1899, and then until 1914 the ice fronts were visited by a number of expeditions including those of

[9] W. S. Cooper: The Recent Ecological History of Glacier Bay, Alaska, *Ecology*, Vol. 4, 1923, pp. 93–128; especially pp. 98–104.

Copper River District, scale, 1 : 500,000, Alaska Road Commission, 1929; topographic sketch map of Harvard Glacier and tributaries by Dora Keen, 1917; (d) observations by the author, 1931.

Grant and Higgins for the United States Geological Survey and Tarr and Martin for the National Geographic Society.[10]

It was the writer's purpose to revisit these glaciers during the fall of 1931 in order to determine their recent behavior and the exact positions of their ice fronts in that year. Furthermore, it was hoped

FIG. 12

FIG. 13

FIGS. 12 and 13—The west margin of Columbia Glacier from Photo Station G. Figure 12: Photograph by G. K. Gilbert (No. 355) in 1899. Figure 13: Photograph by U. S. Grant (No. 91) in 1909 showing an advance in progress (see also Figure 14).

that the old transit and photographic stations, many of which had not been visited for more than twenty years, could be located and occupied and that new ones could be established for future work. In this article it would seem best to consider separately each of the more significant glaciers and to indicate in each case the more important features of their recent behavior.

COLUMBIA GLACIER

The largest glacier of this district under discussion is the Columbia, issuing from snow fields in unexplored sections of the Chugach Range

[10] The principal references: G. K. Gilbert: Glaciers and Glaciation (Harriman Alaska Expedition, Vol. 3), New York, 1904, pp. 71–97 and 175–176; U. S. Grant and D. F. Higgins: Coastal Glaciers of Prince William Sound and Kenai Peninsula, Alaska, *U. S. Geol. Survey Bull. 526*, Washington, 1913, pp. 11–40; *iidem:* Glaciers of Prince William Sound and the Southern Part of the Kenai Peninsula, Alaska, *Bull. Amer. Geogr. Soc.*, Vol. 42, 1910, pp. 721–738; Vol. 43, 1911, pp. 321–338, 401–417, and 721–737; *U. S. Geol. Survey Bull. 443*, 1910; R. S. Tarr and Lawrence Martin: Alaskan Glacier Studies, Natl. Geogr. Society, Washington, 1914, pp. 232–350.

and ending in Columbia Bay in a tremendous lobate front seven miles in length. Its western portion is a magnificent ice cliff over two miles long and 200 to 250 feet high. East of this is a land terminus on Heather Island; and beyond it is the eastern ice cliff more than a mile in length, succeeded in turn by a land terminus of two additional miles.

FIG. 14—The west margin of Columbia Glacier from Photo Station G (see Figures 12 and 13). The condition in 1931 showing the barren zone uncovered by the retreat which followed the advance shown in Figure 13.

On the western margin the recent behavior of the ice front can be traced by comparison of photographs taken in 1899 (Fig. 12), 1909 (Fig. 13), 1914 (photograph by Dora Keen), and 1931 (Fig. 14). These show that the glacier advanced between 1899 and 1909 and continued with one short interruption till after 1914. A retreat then set in which from other sources is known to have been in progress in 1922 and 1929. By 1931 the ice front stood at a point 900 feet from its farthest advance, and there had been a corresponding decrease in the thickness of the ice near the western margin, leaving a barren zone of at least seventy-five feet between the ice and the edge of the forest. Thus the ice front in 1931 was in a position intermediate to those of 1899 and 1909.

Out on the Heather Island front evidence was also found of the recent advance. The forest that former observers saw being destroyed by the advancing ice was overridden, and the trees were piled up in the moraine, later to be exposed by the retreating front. From quite independent observations the time and extent of the oscillations of this portion of the ice front are found to bear marked resemblance to those of the western margin, although it is probable that the ice terminus is still somewhat in advance of the 1909 position. However, these relative positions cannot be determined with any degree of precision since practically all the measurement monuments and photographic stations erected before 1911 have since been obliterated by the advancing ice. The one factor that can be determined definitely is the amount of retreat since the recent maximum, and that varies along this part of the front from 200 to 1500 feet. The eastern ice cliff and the eastern land terminus have also retreated since the recent

FIG. 15

FIG. 16

FIG. 17

FIGS. 15, 16, and 17—The Heather Island terminus of Columbia Glacier. Figure 15: Photograph by U. S. Grant (No. 85) in 1909, of the ice advancing toward the edge of the forest, looking east. Figure 16: The same part of the terminus in 1931 showing the effects of the advance seen in Figure 15 and the subsequent retreat (the lakelet is in approximately the same position as the one in Fig. 15). Figure 17: View west toward the main ice cliff and Columbia Bay showing vegetation gaining a foothold in the area recently occupied by the ice.

advance. Where the former comes up on land at its western and eastern margins the total retreat has been fully 1500 and 2500 feet respectively, while the latter is now fronted by a barren zone 400 to 800 feet wide.

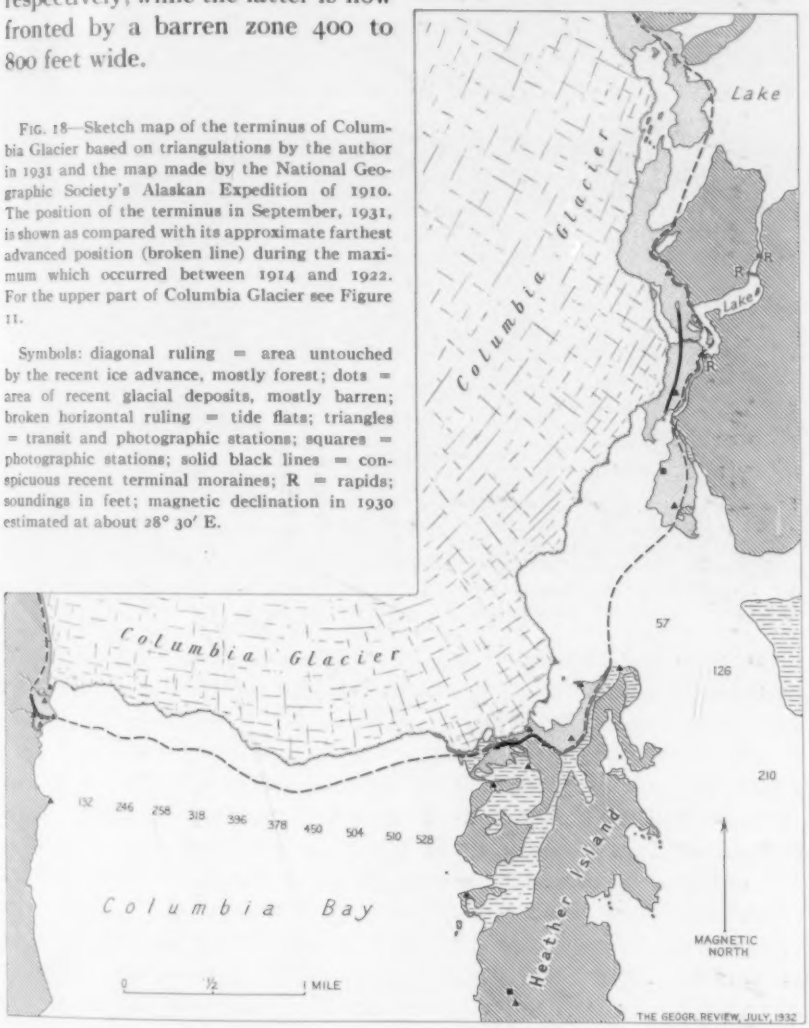

FIG. 18—Sketch map of the terminus of Columbia Glacier based on triangulations by the author in 1931 and the map made by the National Geographic Society's Alaskan Expedition of 1910. The position of the terminus in September, 1931, is shown as compared with its approximate farthest advanced position (broken line) during the maximum which occurred between 1914 and 1922. For the upper part of Columbia Glacier see Figure 11.

Symbols: diagonal ruling = area untouched by the recent ice advance, mostly forest; dots = area of recent glacial deposits, mostly barren; broken horizontal ruling = tide flats; triangles = transit and photographic stations; squares = photographic stations; solid black lines = conspicuous recent terminal moraines; R = rapids; soundings in feet; magnetic declination in 1930 estimated at about 28° 30′ E.

Thus the recent oscillations of these three sections of the Columbia ice front are strikingly similar and form a very definite indication of the behavior of the glacier. This is further corroborated by the clear evidence that the glacier surface has been lowered considerably since 1910.

Some interesting observations were made on the forward movement of the ice along the Heather Island terminus. Measurements from a boulder on the moraine in front of the ice to one on the ice itself showed a forward motion of the ice of slightly more than two

feet in five days, undoubtedly a low figure compared to what would be obtained were it possible to measure the rate of motion in the main current of the glacier farther to the west. Attempts to accomplish this, however, were futile on account of the heavily crevassed character of the central and more rapidly moving parts of the ice stream. In the future it may be possible to make these observations by having

FIG. 19—Yale Glacier from Photo Station P, showing the high mountains of the Chugach Range from which flow the small tributary glaciers that together form the large ice streams.

an airplane drop some form of marker at the desired spot on the glacier, so that accurate transit readings of its daily progress could be made from points on the land.

An advance of the ice terminus was unexpectedly found in progress at the western margin of the main ice front and on Heather Island. Here at one point the ice front came forward 2.2 feet in nine days, while about 300 yards away during that same interval the advance was 2.3 feet or roughly three inches a day. Whether this advance of portions of the Columbia Glacier terminus is to be widespread or merely a temporary forward thrust remains to be seen. It is idle to speculate on this matter without additional data on the advance and more meteorological observations for the area drained by the glacier.

On the west side of Columbia Glacier two miles above its terminus is a large embayment or basin into which considerable ice pours, there to stagnate and eventually melt away and form at certain periods a marginal lake whose drainage is back out under the glacier to Columbia Bay. The behavior of the ice here appears to be variable. The medial moraines in this part of the ice stream suggest this as well as the fact that somewhat different conditions have been observed at various times. As yet, however, the data are too few to warrant an opinion as to the cause of the phenomenon beyond the suggestion that the change is periodic and possibly seasonal.

Shoup and Valdez Glaciers

From the same part of the Chugach Range but flowing to the east of the Columbia are the Shoup and Valdez glaciers. Both show evidences of recent shrinkage in volume of ice but differ from Columbia Glacier in that no great advance was observed in the years following

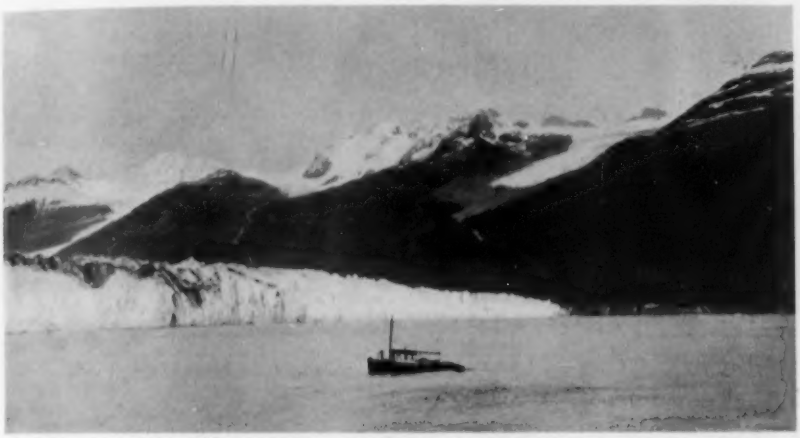

Fig. 20—Harvard Glacier from Photo Station M showing the east margin which has advanced a quarter of a mile since 1914 (see also Figs. 21 and 22). Above to the right in complete contrast is the small ice tongue of Downer Glacier which is fronted by an extensive barren zone indicating recent recession.

1910. The front of Shoup Glacier has remained in almost the same position since 1898, but its appearance has very materially altered. Instead of ending in a vertical cliff as noted by all former observers, the glacier now terminates in a low sloping front which reaches salt water only at high tide. This is due to a very significant reduction in the volume of ice in the lower portion of the glacier which has caused a thinning of the terminus without, however, changing its position.

Valdez Glacier seems to have maintained a fairly steady retreat since 1898 with only one short period of advance between 1905 and 1908. From 1901 to 1911 the average yearly rate of retreat was about sixty-six feet; from 1911 to 1914 it dropped to a yearly average of about fourteen feet;[11] in subsequent years it increased again so that from 1914 to 1931 it was in the neighborhood of seventy-three feet. This rapid shrinking has caused the surface of the glacier to be lowered an estimated distance of fifteen to twenty feet per year, which accounts for the case previously cited in which a mining camp originally built on a level with the ice has been left stranded about two hundred feet up on the valley wall.

West of Columbia Glacier the ice fronts and the conditions of the

[11] Measurement in 1914 made by Mr. Bourke, a resident of Valdez. This and Dr. Camicia's earlier measurements are now kept at the Elks Club of that town.

glaciers are far more varied. Here in Unakwik Inlet and Port Wells with its two arms known as Harriman Fiord and College Fiord, there are seven large tidal glaciers and six smaller ones besides many that terminate on land. For purposes of clarity the large glaciers will be discussed separately starting from the east and following the coast line toward the west. The smaller glaciers of each district will then be mentioned briefly.

Meares Glacier

Meares Glacier at the head of Unakwik Inlet appears to have advanced considerably within the last thirty-three years. In 1898 Captain E. F. Glenn visited the inlet and wrote,[12] "When we arrived at the head of this inlet we found it divided into two arms, both of which were frozen over . . . We were unable, therefore, . . . to examine the glaciers that lay at the head of the two arms." By 1905, when Grant visited that locality, there was no second arm, and the head of the inlet was occupied by a glacier made up of two ice streams coming together a mile and a half above the ice front. This, therefore, suggests that a great advance had taken place between 1898 and 1905 during which the two glaciers had come forward and coalesced into one large ice stream. This advance seems to have continued steadily, for observations made in 1909, 1910, and 1931 have shown the ice front to be progressively farther forward. In the last year the ice was apparently not advancing but was still within a few feet of mature trees showing that it had not been farther forward for more than a century.

Yale and Harvard Glaciers

At the head of the eastern arm of College Fiord is Yale Glacier with a known length of twenty miles and a width at its terminus of nearly two miles. Since 1898 there have been only minor changes in the position of the ice front involving the east and west margins but not the center. The greatest change is along the east side, where the ice has come forward about one quarter of a mile since 1899. It is not now actively advancing, however, and is slightly farther back than its maximum position of recent years.

The Harvard Glacier is the largest in College Fiord and is fed by numerous magnificent cascading glaciers issuing from the slopes of the highest peaks of the Chugach Range. Since 1905 every observation[13] made has recorded an advance amounting in 1931 to a total of at least 2000 feet at the eastern margin and somewhat less on the

[12] Reports of Explorations in the Territory of Alaska, 1898, War Dept., Adjutant General's Office, Washington, 1899, Report by Captain E. F. Glenn, p. 24.

[13] For observations in 1914 see Dora Keen: Exploring the Harvard Glacier, 1914, *Harpers Mag.*, Vol. 132, 1915, pp. 113–125; *eadem:* Studying the Alaskan Glaciers, *Bull. Geogr. Soc. of Philadelphia*, Vol. 13, 1915, pp. 25–32.

western. Again in the case of this glacier mature trees and alders have been destroyed by the advance, and when visited in 1931 the ice was still actively pushing ahead over terrain it had not occupied for many years.

Cascading Glaciers of College Fiord

Several interesting glaciers of the smaller type occur in College Fiord. There, facing the advanced Yale and the advancing Harvard

Fig. 21

Fig. 22

Fig. 21—The east margin of the ice front of Harvard Glacier. In 1914 the small stream entered the fiord a quarter of a mile below the ice front.

Fig. 22—The west margin of the ice front of Harvard Glacier showing the ice advancing into mature alders. A small change in the position of the front due either to advance or retreat may in the future be checked as on the east side (Fig. 21) by comparing the relative positions of the ice terminus and the small stream entering the fiord.

Glacier, are four separate cascading ice tongues plunging side by side down the western wall of the fiord. Each one shows certain similar characteristics such as an advance in 1910, but there are some as yet unexplainable contrasts in their recent behavior.

Smith Glacier advanced nearly 1000 feet between 1899 and 1910. During the next four years there was a slight advance and a subsequent retreat followed after 1914 by another advance of considerable proportions. Since then a great retreat and general shrinkage has reduced the glacier to the condition of 1899.

Next to the south is Bryn Mawr Glacier whose oscillations have been very similar to those of Smith Glacier. Maximums seem to have occurred between 1910 and 1914 and again later, after which a great retreat amounting to over 1500 feet has taken place.

Vassar Glacier has behaved similarly, although the fluctuations have been less pronounced because of a thick covering of ablation

FIG. 23

FIG. 24

FIG. 25

FIG. 26

FIGS. 23 to 25—Meares Glacier. Figure 23 shows the northern margin of the front, the ice in contact with a mature forest. Figure 24 shows the two large tributaries which in 1898 seem to have been separate glaciers terminating in two arms of the inlet. Figure 25 shows the active front discharging into Unakwik Inlet.

FIG. 26—Barry Glacier in the center with Cascade Glacier at the left and Coxe Glacier at the right from Photo Station BB, a rock point which in 1908 marked the position of their combined ice fronts. The water in this fjord attains a depth of over 400 feet.

of their combined ice fronts. The water in this fiord attains a depth of over 400 fathoms. Figure 28 shows the active front discharging into Unakwik Inlet.

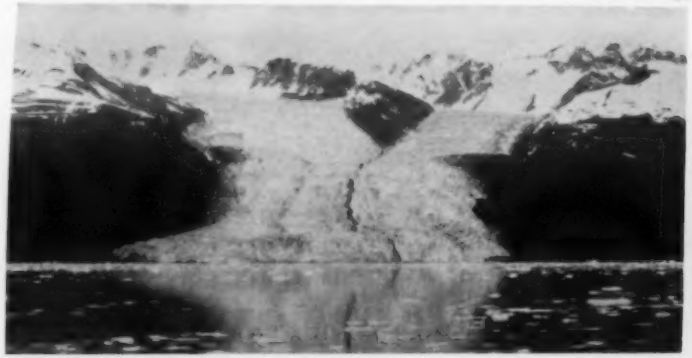

FIG. 27

FIG. 28

FIG. 29

FIGS. 27 and 28—Bryn Mawr Glacier from Photo Station O on College Point. Figure 27: Photograph by U. S. Grant (No. 206) in 1909 showing expanded terminal portion. Figure 28: the same view in 1931 showing the result of a 1500-foot retreat of the ice front and the consequent disappearance of the flattened lobate terminal section.

FIG. 29—The lower cascade and terminus of Bryn Mawr Glacier. All former observers have reported the glacier as extending out into the fiord beyond where the boat is anchored. Soundings reveal that this is a shallow bay with a shoal or former terminal moraine across its mouth.

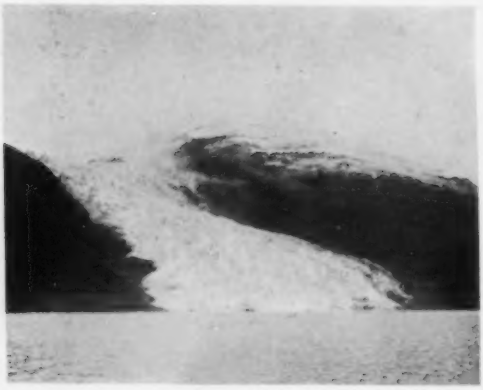

FIG. 30

FIG. 31

FIG. 32

FIG. 30—Wellesley Glacier, cascading 1800 feet.

FIG. 31—East margin of Harriman Glacier at the right, from Photo Station H. Photograph by U. S. Grant (No. 106) in 1909 (compare with Fig. 32).

FIG. 32—East margin of Harriman Glacier from Photo Station H, 1931, showing the ice front about 1500 feet in advance of its 1909 position (see Fig. 31).

moraine that effectively shields the terminal portions from rapid melting. This condition makes it impossible to say whether there was an advance after 1914 and how extensive the subsequent retreat has been.

In marked contrast is the recent behavior of Wellesley Glacier. After the advance seen in 1909 and 1910 there was a pronounced retreat observed in 1914, and then another advance which by 1931 had thrust the ice front out beyond its position of 1910.

BARRY, SERPENTINE, AND SURPRISE GLACIERS

One of the largest glaciers of the Harriman Fiord district is the Barry, which has retreated in most spectacular fashion since 1899. Between that year and 1914 the eastern part of the ice front retreated three and a half miles, and the western nearly three miles. This caused one tributary, Coxe Glacier, to become a separate tidal glacier and all but isolated another tributary known as Cascade Glacier. Since 1914 there has been no very great retreat, but a photograph taken in 1925 indicates that the volume of ice in

the terminal parts of the main glacier was less in that year than in 1914 and 1931.

In the next valley is Serpentine Glacier, whose recent behavior has been somewhat similar in that a general retreat has occurred amounting to about half a mile since 1899. About half of this took place between 1905 and 1910, and the rest since 1914.

Within a few miles of Serpentine and occupying the next valley is Surprise Glacier, whose recent behavior is also similar. The total retreat has been over a mile and a quarter since 1899, most of which was accomplished before 1909. Perhaps the most significant thing about Surprise, Serpentine, and Barry glaciers is that no advance was detected in 1909, 1910, and 1914, whereas nearly all the other ice fronts in the region experienced some sort of forward movement at that time.

Harriman Glacier

At the head of Harriman Fiord is Harriman Glacier with a recent history entirely different from that of its neighbors. A retreat between 1899 and 1909 was followed by an advance in 1910, which was

Fig. 33

Fig. 34

Fig. 35

Fig. 33—Toboggan Glacier in Harriman Fiord.

Fig. 34—Terminus of Toboggan Glacier from a point which marked the position of the front in 1910. The retreat since that time has been over 830 feet.

Fig. 35—Cataract Glacier in Harriman Fiord plunging from a hanging valley at the 2000 foot level. Only within the last six years has the terminus ceased to be tidal.

apparently still in progress in 1914, 1925, and 1931. In 1931 the ice front was about 1500 feet farther forward than in 1909 and was actively advancing as shown by the existence of a push moraine at the south margin of the ice front.

Smaller Glaciers of Harriman Fiord

The smaller glaciers of Harriman Fiord are all in a state of retreat, but their past histories have not been similar. The most important of these is Toboggan Glacier, where very precise measurements dating from 1905 are available. Between that year and 1909 there was an advance of at least 400 feet followed by a retreat of 650 feet. From 1909 to 1910 the retreat was 75 feet and, continuing until 1931, amounted in the interval to more than 830 feet.

Across the fiord and directly between Serpentine and Surprise glaciers, both of which seem to have retreated steadily since 1899, is Baker Glacier, a small hanging glacier which between 1909 and 1914 had a relatively great advance. A considerable retreat and shrinkage has followed leaving the 1931 condition of the glacier very similar to that of 1905.

Another strange contrast is to be found in the case of Roaring Glacier, situated within two miles of the Harriman Glacier. This small ice stream advanced between 1910 and 1914 and later shrank back to a position and condition similar to that of 1899. Almost the same fluctuations are noted for Cataract Glacier, which increased in volume between 1910 and 1914 and then retreated. However, one additional observation is available showing that in 1925 the volume of the ice stream was less than in 1931 and yet paradoxically the terminus was more advanced.

Summary of Observations

Here then in the northern part of Prince William Sound is to be found a variety of conditions offering a splendid series of problems to the student of glacial fluctuations. There are six big glaciers and seven smaller ones that have retreated or shrunk in volume since 1910; two big glaciers and one small one more advanced than in 1910 but apparently not now advancing; and two large glaciers, the biggest ice streams of their respective fiords, now advancing as they seem to have been doing since 1909. Besides these there are many small glaciers nearly all of which are now shrinking.

One of the most interesting features of the problem is that mere proximity does not necessarily imply similar behavior among a set of glaciers. The two advancing glaciers in College and Harriman fiords are thirty-three miles apart, while between them are three large and five small retreating ice tongues; within five miles of the advancing

Harvard Glacier are Smith and Bryn Mawr glaciers, both of which have shrunk and retreated in recent years. The general advance seen in 1910 apparently did not affect four large glaciers and several small ones, and the period of slight recession noticed in 1925 affected but a few of the ice fronts. Some of the fluctuations have been short and spasmodic, while others have been drawn out over a period of several years. In still other cases there seems to have been a steady retreat or advance marked by little or no apparent fluctuation during the last thirty years.

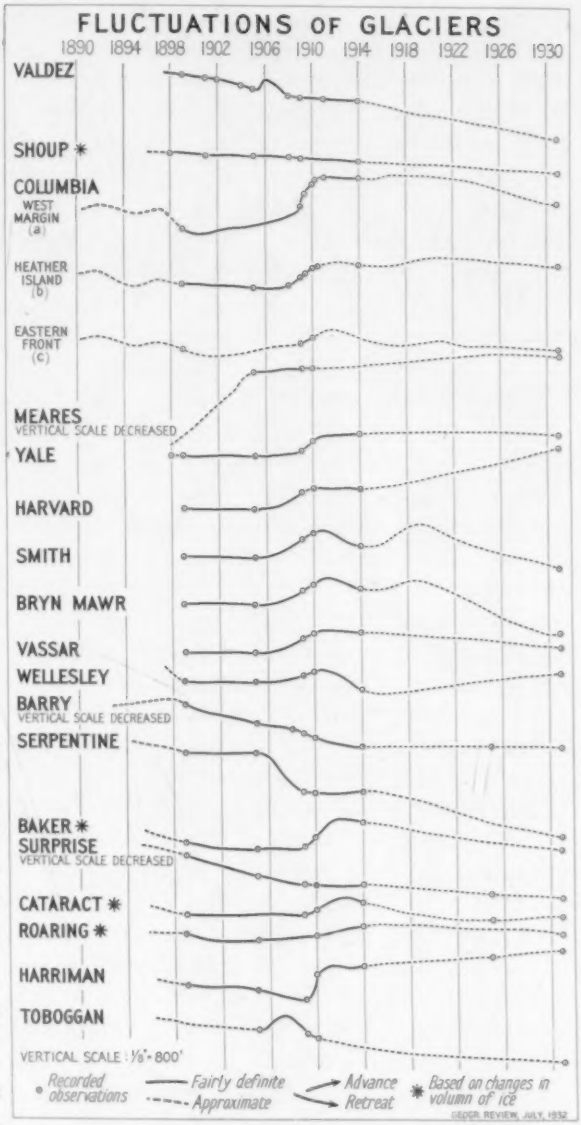

FIG. 36—Diagram to show the fluctuations of the more important glaciers on the northern side of Prince William Sound. Except for certain cases where the exact amount of advance or retreat has been measured, these readings are based on estimates in the field and a comparison of photographs. There is direct evidence for each curve shown, although it is not always known what year the advance or retreat took place. When there is no evidence of fluctuation during an interval a straight line has been drawn from the earlier to the later observation.

Fluctuations are shown to the same vertical scale except in the case of Barry, Meares, and Surprise glaciers, where the fluctuations have been exceptionally great, particularly so in the case of spectacular retreat of the first named.

CAUSES OF GLACIER FLUCTUATIONS

The basic reason for the growth, maintenance, and disappearance of glaciers and snow fields is, of course, climatic. With other conditions remaining unchanged, an increase of snowfall in a region where gla-

ciers exist should cause an enlargement of those glaciers and an advance of their fronts; the reverse should also be true. Each glacier would show some response to the change which, although not parallel, would be recognizable even when an allowance is made for the fact that the terminal portions of glaciers of different length would necessarily be affected at different times. At any rate one would expect to be able to correlate the fluctuations of the various ice fronts more closely than now seems possible in the Prince William Sound region. Other causes than ordinary changes in meteorological conditions must be sought.

An explanation was offered by Tarr and Martin after they had observed the quick and spasmodic changes occurring in the glaciers of the Yakutat Bay region in 1905 and 1906.[14] They advanced the hypothesis that severe earthquake shaking would provoke avalanches in the upper reaches of the glacier and that the increased supply of snow suddenly loaded onto it would cause a "wave" to be transmitted down its length, thickening the ice stream as it passed and causing a relatively quick and spasmodic expansion and advance of the terminal sections. Different glaciers would respond in different ways and at various times to this "wave" according to the forms of their basins and the length of their courses. Thus one short glacier might show an advance over a period of one or two years, then resume its former condition long before the front of a near-by glacier of greater length was in the least affected. It is also probable that after such an advance there would be a period of abnormal retreat due to the lessened amount of ice issuing from the reservoirs temporarily depleted by the premature avalanching and the passage of the ice flood down the glacier.

This diversity of effects produced by earthquake avalanching on glaciers differing greatly in length may be closely simulated by the effects of extra heavy snowfall in a given year or series of years. A short glacier will respond more promptly to a great accession of snow than a long one, so that it may happen that some short glaciers after making a pronounced advance will again be receding while the longer glaciers, owing to "reservoir lag," are only just beginning to advance. It must be remembered also that it takes a "wave" of excessive snow many years to translate itself down to the front of a very long glacier. During this time the snow may be mostly melted, with the consequence that the final effect at the terminus may be insignificant.

It has already been pointed out that if the fluctuations were due entirely to climatic conditions it would probably be possible over a period of twenty or thirty years to detect some relationship between the behavior of these glaciers. Similarly, advances due to earthquake avalanching alone should show more regular tendencies than those

[14] R. S. Tarr: The Yakutat Bay Region, Alaska, *U. S. Geol. Survey Professional Paper 64*, Washington, 1909, pp. 11–144; R. S. Tarr and Lawrence Martin: Alaskan Glacier Studies, Natl. Geogr. Society, Washington, 1914, pp. 168–197.

mentioned above. There remains the possibility that a combination of both factors may have been largely the cause of the recent fluctuations of these glaciers.

There are, however, many other minor factors to be considered; as, for example, the shape, the size, the height, and the general position of the snow fields feeding a glacier or a set of glaciers, all of which would somewhat modify the results of climatic change or earthquake avalanching. In the case of tidal glaciers there is an important factor in the temperature of the water in which the ice front rests and to which it is highly sensitive. These studies are as yet in their infancy and are handicapped by the lack of specific data with which to work, especially with regard to the Alaskan glaciers. It must be emphasized that, tremendous and seemingly permanent as a glacier appears, its existence is controlled by factors whose adjustment is very delicate. A slight change in any one of several conditions such as ocean currents, winds, elevation of the land, precipitation, solar radiation, etc., may result in profound changes. It seems worthwhile to recall here G. K. Gilbert's clear statement of the case.[15]

> . . . the combination of a climatic change of a general character with local conditions of varied character, may result in local glacier variations which are not only unequal but opposite. The general drift of the suggestion may be illustrated by considering some of the more evident consequences of an assumed change in the temperature of the water of the Gulf of Alaska. Let us assume that the water becomes warmer, and that all other factors affecting glaciation remain unchanged. The consequences would include:
>
> 1. A higher temperature for the air currents flowing from the Gulf to the land.
> 2. A greater contrast in temperature between the coastal belt and the interior of Alaska, especially in winter.
> 3. Greater evaporation from the ocean and a higher humidity for the landward-flowing air—resulting from 1.
> 4. Greater precipitation on the mountains, especially in winter—resulting from 2 and 3.
> 5. A shorter annual period in which precipitation takes the form of snow—resulting from 1.
> 6. A (probably) lower ratio of snow to rain—resulting from 5, qualified by 4.
> 7. A higher snow-line.
> 8. More rapid waste of ice and snow by evaporation and melting—resulting from 1, 5 and 7.
>
> Of these consequences, the increase of precipitation would tend to enlarge glaciers, while the lessened ratio of snow precipitation and the enhanced wasting would tend to reduce them.

If there is a cycle of alternate advance and retreat of the Alaskan ice fronts such as is believed to have been detected in the Alps, it is a much longer one extending over many centuries.[16] Recent studies

[15] Gilbert, *op. cit.*, pp. 109–110.

[16] R. S. Tarr: Glaciers and Glaciation of Alaska, *Annals Assn. of Amer. Geogrs.*, Vol. 2, 1912, pp. 3–24; reference on p. 18.

in Glacier Bay[17] have shown that the glaciers of that district have experienced since Pleistocene times several large fluctuations in which they have ranged from being very restricted to the stage where they filled most of the valleys and submerged many of the lower mountain ridges. The relationship of these cycles to any in other districts is not known, nor are the causes agreed upon.

The more immediate problem is to explain the minor fluctuations such as those described above. Climatic records are needed as well as many more observations. This last is a task that is not too difficult for the intelligent traveler, explorer, or mountaineer. Valuable work can be accomplished by simply obtaining photographs of the ice fronts, and these can be made the more effective by taking the pictures from the established photographic stations. To extend the work to detailed measurements combined with observations of a more technical kind requires more time, patience, and knowledge. So much of the work is of a pioneering and definitely original nature that to many it should prove all the more fascinating. And coördination and systematization of data are now possible owing to the interested coöperation of the Committee on Glaciers of the American Geophysical Union.

PHOTOGRAPHIC COLLECTIONS OF THE PRINCE WILLIAM SOUND GLACIERS

	DATE	WHERE FILED
W. C. Mendenhall	1898	U. S. Geological Survey
F. C. Schrader	1898	U. S. Geological Survey
C. H. Merriam	1899	Set of prints filed in collection of Committee on Glaciers*
G. K. Gilbert	1899	U. S. Geological Survey
E. S. Curtis	1899	Set of prints filed in collection of Committee on Glaciers*
S. Paige	1905	U. S. Geological Survey
U. S. Grant	1908, 1909	U. S. Geological Survey
R. S. Tarr and L. Martin	1909, 1910 1911	National Geographic Society
B. L. Johnson	1913, 1914 1915	U. S. Geological Survey
Dora Keen Handy	1914, 1925	National Geographic Society and set of prints filed in collection of Committee on Glaciers*
F. H. Moffit	1925	U. S. Geological Survey
W. O. Field, Jr.	1931	Set of prints filed in collection of Committee on Glaciers*

[17] W. S. Cooper: The Recent Ecological History of Glacier Bay, Alaska, *Ecology*, Vol. 4, 1923, pp. 93–128; especially pp. 104–127; *idem*, A Third Expedition to Glacier Bay, Alaska, *ibid.*, Vol. 12, 1931, pp. 61–95; especially pp. 88–93.

* The photographic collection of the Committee on Glaciers of the Section of Hydrology of the American Geophysical Union is at present in the Division of Maps of the Library of Congress, Washington.

THE RECENT RETREAT OF McCARTY GLACIER, ALASKA

Paul C. Whitney
U. S. Coast and Geodetic Survey

McCARTY Glacier, one of the many glaciers draining the vast ice field of the Kenai Peninsula, Alaska, reaches sea level in the upper end of East Arm, Nuka Bay. Recent surveys of this bay by the U. S. Coast and Geodetic Survey, when compared with a previous reconnaissance, bring to light an interesting example of glacial retreat. In 1909 this region was examined by the U. S. Geological Survey,[1] and the result of this reconnaissance placed the face of this glacier as shown in Figure 1. From the same source it is learned that the glacier retreated about one quarter of a mile in the fifty years before 1909 and that at some time during that period it occupied its most advanced position since the growth of the present trees.

Figure 2, a section of U. S. Coast and Geodetic Survey Chart No. 8530, shows East Arm as a U-shaped trough, with relatively high hills close to the water's edge, typical of all arms left by retreating glaciers. From its mouth to within a mile of the glacier front of 1909 the depths along the center line decrease from 127 fathoms to 100 fathoms. From the latter location to the terminal moraine the depths shoal rapidly to a visible beach at low water along the base of the glacier (Fig. 3).

In 1925, when surveys of this section were undertaken by the U. S. Coast and Geodetic Survey, the glacier was found to be in retreat. An examination of Figure 4, a photograph taken in that year, shows the position of the front approximately as outlined on Figure 2. In 1927 when the glacier was surveyed it had retreated 1.9 miles since 1909.

At one time the glacier occupied the entire East Arm and (with another in West Arm) probably all of Nuka Bay. Retreat up East Arm was comparatively rapid and uniform until it reached a position somewhat in advance of the front of 1909. Here the rate of retreat decreased, as is evidenced by the shoaling. Later and for many years the glacier front was at a standstill as is disclosed by the building up of

[1] U. S. Grant and D. F. Higgins: Coastal Glaciers of Prince William Sound and Kenai Peninsula, Alaska, *U. S. Geol. Survey Bull. 526*, 1913, pp. 62–64; *idem:* Glaciers of Prince William Sound and the Southern Part of the Kenai Peninsula, Alaska, IV: Glaciers of the Southern Coast of the Kenai Peninsula, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 721–737.

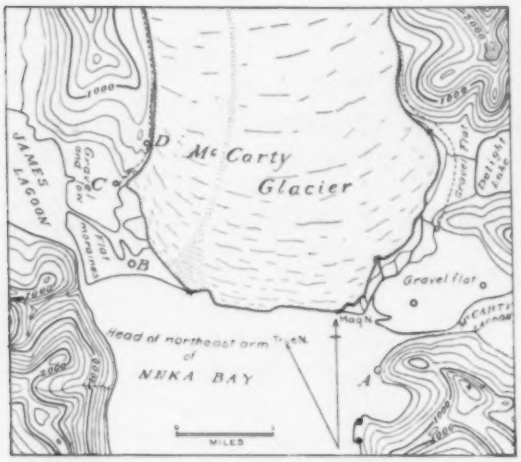

FIG. 1—Front part of McCarty Glacier, July 30, 1909, from reconnaissance by U. S. Geological Survey.

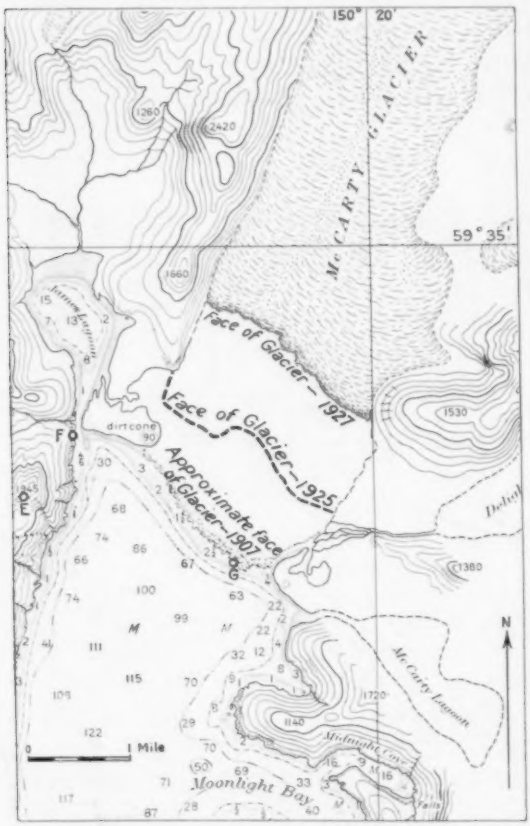

FIG. 2—Section of U. S. Coast and Geodetic Survey Chart (No. 8530) of upper part of East Arm, Nuka Bay, from surveys in 1927.

terminal moraine from depths of 100 fathoms to somewhat above mean lower low water. Subsequent to 1909 it began a retreat, probably slow at first, as Figure 4 indicates that by 1925 it reached the line sketched on Figure 2. It is interesting to compare Figure 6 with Figure 5. In the former is shown the "dirt cone" just emerging from the face of the glacier, whereas Figure 5 shows the face far to the rear of the dirt cone. The medial moraine which terminated over the position of this dirt cone up to 1909 was undoubtedly the source of material for its formation during the period of standstill of the glacier. From 1925 to 1927 the retreat was rapid, the front falling back a full mile in that time, Figure 5.

The area in front of the glacier to the terminal moraine of 1907 was choked with icebergs, many of which floated over the moraine at high tide and were carried seaward. The scouring effect of these bergs eroded the moraine so that none of it was visible at the lowest tides in 1927. Sound-

ings taken just to the northward of the moraine gave depths of no bottom at ten fathoms, indicating a rapid deepening to the northward. Owing to the congestion of icebergs in this area, farther penetration by the survey launch was impossible. It will be of great interest to learn whether depths of the same order prevail in this area to the southward of the moraine.

Probably a similar history of glacial retreat is found near the head of Aialik Bay, where Aialik Glacier left a bar across the bay centuries ago. Examples, however, are rare in Alaskan waters. We are fortunate to have witnessed this interesting phase of glacial retreat and thereby more clearly to see the reasons for the bars that exist across glaciated bays. The writer leaves to others the interpretation of the fluctuations.

FIG. 3—McCarty Glacier, central front from A, Fig. 1, July 30, 1909. (Photograph by U. S. G. S.)

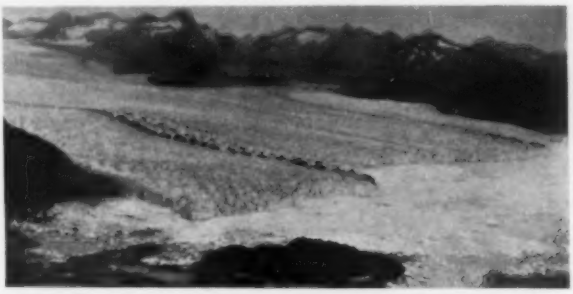

FIG. 4—McCarty Glacier, 1925, from E, Fig. 2. (Photograph by Lieut. Paul Smith.)

FIG. 5—McCarty Glacier, 1927, from F (approximately), Fig. 2. (Photograph by Lieut. Paul Smith.)

FIG. 6—McCarty Glacier, west front, July 30, 1909, from B, Fig. 1. (Photograph by U. S. G. S.)

ITALIA PASS IN THE EASTERN KARAKORAM

Giotto Dainelli
University of Florence

IN the eastern Karakoram there are, as we know, six of the largest glaciers on earth outside the polar regions. The most easterly of these is the Rimu, which, nearest the Tibetan plateaus, has the aspect of a tableland glacier as it adapts itself to the underlying topography.

Earlier Explorations

Until the De Filippi expedition of 1913–1914[1] only the snout of the Rimu Glacier, visible from one of the abandoned caravan roads of the Karakoram Pass, was known. The expedition ascended the three large branches that join to form the gigantic tongue of the glacier. Of these branches the southern one appeared to be distinctly enclosed by a well defined mountain circle. The northern branch, however, held surprises in store: some 12 miles above the large tongue whence originates the Shyok River this branch flattens, and across it passes the watershed line of the mountain range. Far from being simply a glacier saddle it is an uncertain watershed on ice, which evidently duplicates and perhaps exaggerates the underlying topography. Beyond, a lateral tongue gives birth to the Yarkand River. Between the northern and southern branches of the Rimu lies a third, intermediary or central branch. The De Filippi expedition climbed this central branch but went little beyond the snow limit, and its head was described and represented on the topographic map (scale 1:100,000) as it appeared from a distance; that is, shut off by the principal watershed ridge of the Karakoram Range on the north, to the west connected by an ample level pass with the Siachen Glacier.

The Siachen Glacier had been explored only a short time previously by Dr. T. G. Longstaff. In 1909 he had ascended the Bilafond Glacier from the Saltoro Valley in Baltistan and, descending the pass at its head, had met an immense unknown glacier. From the Nubra Valley some months later he climbed the tongue of the Siachen Glacier, ascending it until he recognized in the distance the mountains seen earlier enclosing the unknown glacier. In 1911 and 1912 the American alpinists Dr. and Mrs. Workman also visited the Siachen by

[1] The writer was geographer and naturalist on the expedition, making his own excursions independently of the chief and his other companions.

the Saltoro Valley. The second season they remained for a month and a half and brought back a map on the scale of 1:150,000, not all of it, however, equally faithful and detailed, nor complete. At about half its length—which is no less than 42 miles[2]—the Siachen receives its main lateral affluents: from the west the Lolofond Glacier, its

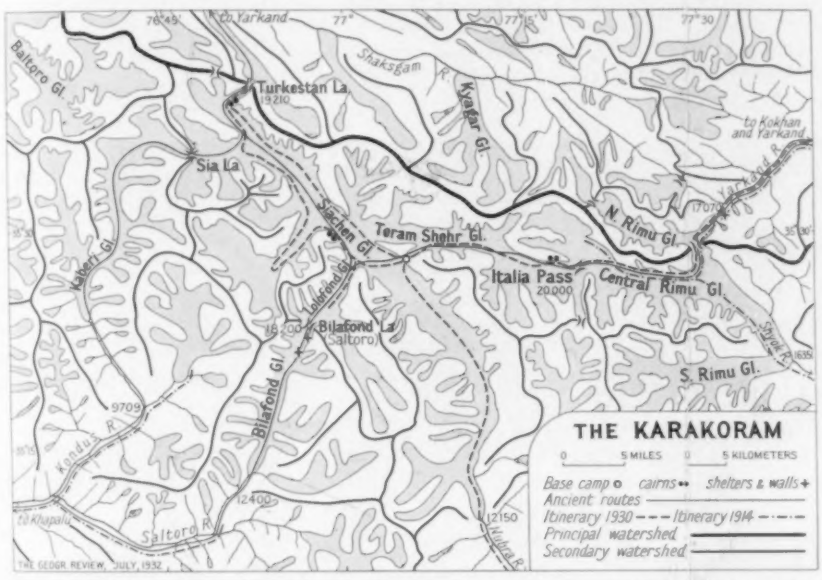

FIG. 1—Glaciers and watersheds of the Karakoram. The author's routes on the expeditions of 1914 and 1930 are shown and the ancient caravan routes, including that from the Saltoro Valley to the Yarkand River by way of the Italia Pass. Scale of map approximately 1 :950,000.

head reaching the Bilafond Pass; from the east the Teram Shehr, itself about 17 miles in length. The Workmans thought that the Teram Shehr branch would lead to a pass through which the then unexplored Rimu basin could be reached or to some other unknown glacier basin. In the endeavor to prove this hypothesis they reached a point on the glacier of over 18,300 feet but were unable to reach the pass or indeed to see it. The De Filippi expedition climbing the central Rimu saw to the west at a distance from it of at least four miles, at the top of the central Rimu, a large depression in the ridge line which was presumed to represent the pass. It could not be, however, clearly identified.

In 1926 Mason made his exploration of the Shaksgam Valley, immediately north of the main Karakoram watershed. The topographic results of his expedition figure in the new edition of the Survey of India map on the scale of 1 inch to 4 miles (sheet 52 E, Karakoram Pass). But the position of the pass between the two

[2] For a time the Siachen Glacier was believed to be the largest glacier outside the polar regions: Rickmers' Alai-Pamir expedition found the Fedchenko Glacier to be 48 miles long.

FIG. 2—The upper half of the Siachen Glacier. The Lolofond Glacier enters on the left (1), the Teram Shehr in the center; 2, Mt. Hawk; 3, Mt. Rose; 4, hollow in which the base camp (Fig. 8) was situated.

FIG. 3—The Italia Pass, seen from the north. The pass is just to the right of the crevasses in the center.

FIG. 4—A caravan en route to establish a supply depot.

FIG. 5—The Bilafond Pass seen from the east, from the Lolofond Glacier. This col was crossed by the old route to the Yarkand Valley from the Saltoro. Compare Figures 2 and 9.

FIG. 6—The Italia Pass, seen from the east, from the author's first camp on the central Rimu.

FIG. 7—On the Italia Pass looking east. The mountains to the left are those on the left flank of the central Rimu.

great glaciers was still indefinite, because no expedition had certainly seen it. Indeed, from what I remembered of the topographic conditions of the Rimu, in spite of unfavorable conditions of visibility, the representation of its head on the new Survey of India map seemed improbable.

Program for 1930

Thus, when I planned an expedition of my own[3] to the Siachen glacier, the geology of whose immense basin was absolutely unknown, I included in my program the exit towards the Rimu, to ascertain the position of the connecting pass and the actual conditions at the head of this glacier.

My program did not present itself as an easy matter, to judge by the experiences of the others who, as Longstaff has expressed it, "have knocked at these closed doors." And in fact if my foresight had not led me to convey to the snout of the Siachen the food supplies needed by my entire caravan of more than 70 men for more than three months, I might have failed completely.[4] On June 6, 1930, I was at the foot of the Siachen. About twenty days after I had ascended the glacier the Nubra became unfordable and thus shut me off completely from the outer world.

My base camp was established in the central part of the glacier on the low junction ridge of the Teram Shehr affluent, near the Workmans' old camping place, at 15,676 feet elevation. During two months' stay there the Siachen was covered almost completely, and rock and fossil collections were made. Of special interest are the fossils, numerous though not well preserved, which probably represent the Rhaetic Period and which no one had ever collected before—not even myself during the De Filippi expedition—in the region between the Karakoram and Himalaya. Miss Kalau, a member of my expedition, made an interesting botanical collection, at altitudes above 15,750 feet. Not only does it present the richest collection of Karakoram alpine flora, but the greatest part of it, coming from the immediate neighborhood of the base camp, is from a real "island" amidst glaciers: the nearest locality in which there is any vegetation, the front of the Siachen Glacier, is 22 miles distant.

After a two months' stay on the Siachen I had to think of leaving, because the persisting Nubra flood had prevented me from obtaining further food supplies. Moreover, as I did not intend to give up my plan of leaving by the unknown pass towards the Rimu Glacier, it was most important not to run the risk of delays by conditions of weather or ground.

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[3] Giotto Dainelli: La mia spedizione nel Tibet occidentale, *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 7, 1930, pp. 865–882.

[4] For details of the expedition see the author's paper "A Journey to the Glaciers of the Eastern Karakoram," *Geogr. Journ.*, Vol. 79, 1932, pp. 257–268.

In reality I did not find great difficulties in the ground. Where the Workmans had been obliged to give up there is indeed a great fall of large *séracs* with deep crevasses in every direction, which might have formed a serious danger and perhaps also have proved an insuperable obstacle for a caravan of laden porters. But I could avoid it by following the middle of the glacier where crevasses were less numerous and less dangerous. But what made my position really difficult was the bad weather that reigned for nine days running, with dense fog, nearly continuous snowfalls, and violent windstorms.

Crossing the Italia Pass

However, at my last camping place below the pass the weather finally cleared. The crossing of the pass was made on August 15 under a perfectly serene sky that allowed me to study the topographic surroundings. No traveler had ever crossed or reached the pass before or even seen it. The elevation is about 20,000 feet. I named it "Italia Pass."

The pass, which is a typical tableland pass—although the whole Siachen basin and even the Teram Shehr Glacier leading towards it represent a system of deeply excavated valleys—is situated about two miles farther east than appears on the Survey of India map. The line of maximum height, however, may vary, it being, a large and level pass entirely filled with névé: the placement of the divide probably depends on the snow conditions of the basins leading to it. The head of the more western of the central Rimu affluents reaches towards the north that main ridge of the Karakoram whose position has been determined by Mason; therefore the long glacial basin, represented on the Karakoram Pass sheet of the Survey of India map (1 inch to 4 miles) as a northern Rimu affluent does not exist. The whole vast snowfield flows from the north as a gigantic snow fan to the Italia Pass, and thence in part to the central Rimu, in part even into the Teram Shehr, that is towards the Siachen Glacier. The Survey of India map also shows a deep valley, running from east to west, in the rocky northern side of the pass;[5] but in reality it does not exist: its presence simply results from the fact that the map is here based on those of De Filippi and of the Workmans, in which the same rocky ridge on the right of Teram Shehr has been assigned two different and parallel positions.

From the pass, going eastward, I descended the whole central Rimu; then passed on to the northern Rimu and left it by the lateral tongue that constitutes the source of the Yarkand River, as I had already ascertained during the De Filippi expedition. I found the

[5] See the comparative sketch maps of the upper basins of the Rimu and Teram Shehr glaciers from the Survey of India map, 1928, and Dainelli surveys of 1930, Filippo de Filippi: Himalaya Karakoram and Eastern Turkestan, 1932, reviewed in this number of the *Geographical Review*

Rimu in an evident state of advance, considerably more swollen than it was sixteen years ago: the moraine between the central and northern Rimu, which at that time dominated the glacier, was now smothered in ice; the glacier tongue in the Yarkand Valley, quite flat sixteen

FIG. 8—The base camp on the junction ridge of the Teram Shehr and Siachen glaciers. See Figure 1.

years ago, now ended in an insuperable wall about three hundred feet high.

ANCIENT ROUTES ACROSS THE KARAKORAM

I had previously collected testimony and traditions on the basis of which it was possible to reconstruct the ancient caravan routes across the Karakoram. One of these ancient ways coming from the Saltoro Valley in Baltistan ascended the Bilafond Glacier, crossed the Bilaphon La, descended onto the Siachen Glacier, and traversing it climbed the whole of its Teram Shehr affluent up to a col leading towards the lateral tongue that gives origin to the Yarkand River. This would have been, in fact, the most direct way between Baltistan and Sanju in Chinese Turkestan. I shall recall briefly the evidence on which my conclusion was founded before giving the confirmation afforded by my recent journey.[6]

[6] See Giotto Dainelli: Le condizioni delle genti, Spedizione Italiana de Filippi . . . 1913-1914. Ser. 2, Vol. 8, Bologna, pp. 190–229.

FIG. 9

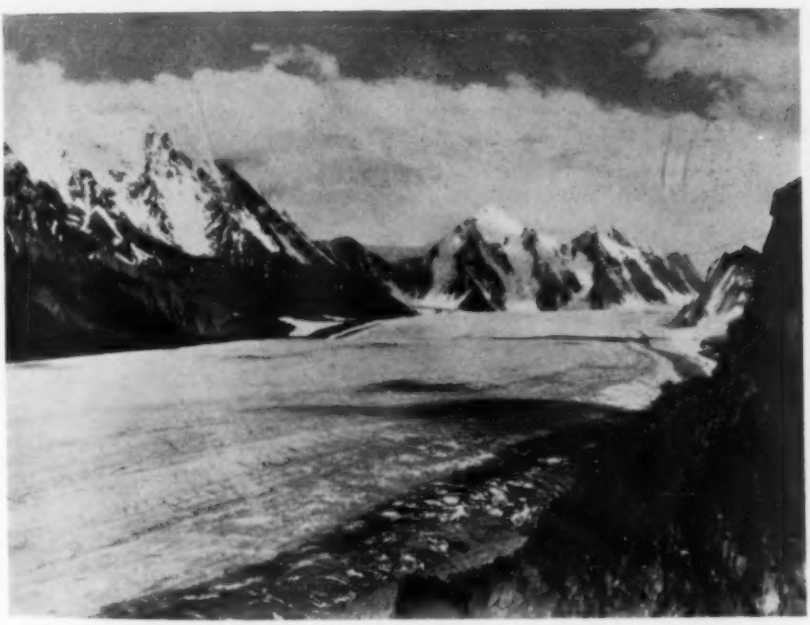


FIG. 10

FIG. 9—The Lolofond Glacier opens into the Siachen. The ancient route followed it, thence crossed the Siachen; see Figure 2.

FIG. 10—The lower part of the Teram Shehr Glacier.

It is quite likely that this route was used in the first half of the sixteenth century by Mirza Haidar, prince of Kashgar. More positive indication we owe to Mir Izzet Ullab, in the account of his travels in central Asia, 1812–1813.[7] He makes mention of the Khafalun (=Khufelang) locality on the north side of the Karakoram Range, whence there was a short road to Baltistan. In 1835 the English traveler Vigne, being in the Saltoro Valley, heard of the existence of a way which, after crossing a col at the summit of some glacier, descended to the head of the Nubra Valley. He imagined it might lead to Kokhan and even attempted to explore it, starting to climb the Bilafond Glacier, without, however, reaching the pass. G. W. Hayward, during his explorations in the region north of the Karakoram Pass in 1868, having climbed, from Khufelang, the western branch of the Yarkand River up to that small lake which he believed to be the source of the river, was told of a very difficult way over a col "probably not less than 19,000 feet above the sea" leading into Baltistan. T. E. Gordon (1873) also was informed of the existence of such a way, followed in ancient times by invaders on horseback penetrating from the north into Ladakh and Baltistan, but then used only occasionally by Baltis on foot. At the same time also R. B. Shaw was told that, from near the Karakoram Pass, Khapalu in Baltistan could be reached in about a dozen stages—a feat which could only be achieved across the Rimu and Siachen glaciers and by the Saltoro Valley.

In 1889, Younghusband, after climbing the Shaksgam Valley, sighted a pass that he was informed was the "Saltoro." It was believed at first to be identical with the pass of this name at the head of the Baltistan Valley. But the tradition of a way across it did not seem to meet with great favor, and later corrections introduced by Younghusband into his own itinerary negatived the idea. Between his "mysterious Saltoro Pass" and the true Saltoro Pass there intervened a blank unknown region—the upper basin of the Siachen Glacier, effectively discovered by Dr. Longstaff in 1909.

Longstaff also heard of the tradition that an abandoned route existed between the Saltoro and the Turkestan valleys. When climbing the Bilafond Glacier he found on a moraine just beneath the pass at the summit traces of low stone walls evidently constructed in ancient times as temporary shelters; however, if they offered proof of the ancient practicability of the pass, Longstaff did not believe that it was used except as a short cut to the neighboring Nubra Valley. Moreover, Neve had confirmed the ancient tradition, adding that the old way, abandoned some hundreds of years, had gone by the Bilafond Pass and then by the Siachen and Rimu glaciers.

The Workman expedition found new evidence. On the upper

[7] Izzet Ullab: Travels Beyond the Himalaya, *Journ. Royal Asiatic Soc.*, Vol. 7, 1843, pp. 283–342.

Bilafond glaciers they discovered besides the low walls indicated by Longstaff the remains of eight rough stone shelters and a stone circle about three and a half yards' diameter and evidently of man's handiwork at the junction of the Siachen and Teram Shehr. They also found the remains of two cairns on the upper Siachen near the Turkestan La—a col on the main watershed range. Their report, however, was not available to me when I went into the field with the De Filippi expedition (1913–1914). I was not then acquainted with the old literature on the region: hence my observations were entirely independent and uninfluenced.

When I was in the Saltoro Valley I heard that until about 1865 a route to Yarkand was in use which climbed the Bilafond Pass, crossed a large glacier, and then led over a second elevated col called the Gayanri Pass. In the neighboring Kundos Valley also it was reported that the Baltis used to go to Yarkand by a col, surely the Sia La leading to the Siachen, then traversed a large glacier, and finally also crossed the Gayanri Pass. I was told that Seid Ali Hamdani—who, about 340 years ago, converted the inhabitants of Baltistan to Islamism—came twice into this region from Turkestan, following the ancient routes: once by the way that leads into the Saltoro Valley, the other time by that leading into the Kundos. I was also told that Yarkand plunderers used to follow these ways to invade and plunder the Baltistan villages. My toponomastical researches led me to think that the village of Korkun, in the upper Kundos Valley, was originally a settlement of Yarkand people. I was therefore convinced that the old ways had really existed and were traveled up to recent times—as I was told by my informants, chosen from the most trustworthy of the elder natives.

FIG. 11—Cairn (on the left side of the rock slope at the top of the photograph) below the Italia Pass.

FIG. 12—Another cairn (on rock slope at extreme right) below the Italia Pass. Seen from the camp on the upper part of the Teram Shehr Glacier.

Field Evidence of Ancient Routes

When I then stepped down from the northern tongue of the Rimu into the Yarkand Val'ey, I discovered near the tongue itself a rock shelter evidently improved by the work of human hands but also evidently long out of use. On my recent expedition I did not find the stone circle of three-and-a-half-yards' diameter at the junction between Siachen and Teram Shehr reported by the Workmans. I saw only the traces of two small adjacent and very irregular half-circles, which I prefer to consider as natural formations rather than attribute to the work of human hands.

However, I saw the remains of a cairn on the slopes to the left of the upper Siachen, about three miles from the Turkestan La; and I found two other cairns, clearly recognizable though badly preserved, on the right side above the junction between the Siachen and its glacier affluent from the Bilafond La—sure signs of an ancient route from the Saltoro Valley, up the Siachen, and into the Shaksgam Valley.

But it is equally certain that this was not the only way. Probably it was an off-branch of a main route that went across the Siachen, climbed the Teram Shehr affluent, crossed a pass at its head, and then descended the Rimu to the Yarkand River. On the right side of the upper Teram Shehr, just below the Italia Pass, I found two cairns, one of them perfect in construction and preservation. Again, on the alluvial plain of the Yarkand River, a short distance from the glacier front and the shelter already observed during the De Filippi expedition in 1914, I found a human jaw of evidently ancient date, a souvenir of one of the ancient wayfarers.

Thus I have had the satisfaction of confirming my hypothesis on the use of this ancient way across some of the greatest glaciers on earth: a satisfaction which has not diminished that other one, namely to have crossed with laden caravan and with no small difficulties of ground and weather the heretofore unknown pass between Siachen and Rimu—the Italia Pass.

THE SALT INDUSTRY IN ECUADOR

George Sheppard

IN Ecuador the salt industry is controlled by the government, and the sale of salt is virtually a state monopoly. An early reference to this control runs thus: ". . . The Lieutenant, invested with the civil government, resides at the town of Punta, two leagues from the port, where there are, indeed, warehouses, or rather sheds, for receiving salt and other goods, but no dwelling houses." "The port of Punta has so many salt works, that it supplies the whole province of Quito and the jurisdiction of Guayaquil. The salt is not the finest, but remarkably compact, and answers very well the principal intention, that of salting flesh." ". . . Vessels belonging to the merchants of Guayaquil of two hundred tuns, load here with salt; a trade, which from the cheapness of that commodity, turns to very good account."[1]

Punta is the present Salinas, situated near the headland of Santa Elena, and it seems reasonable to assume that the primary use of the salt at that time was not so much as an article of food in a direct sense but as a means of preserving fish not only for the use of the inhabitants but possibly for the Spanish galleons which frequently called there for supplies. The demand for salt is not vital amongst the coast dwellers, since they can resort to sea water in case of necessity; but they put salt to good use in curing the excellent fish that abounds in the coastal waters and constitutes their staple diet. The fish is of a firm-textured and cool-water variety—the Humboldt Current flows near the coast for many months of the year—and when the fishermen have been fortunate in their harvest the womenfolk preserve the surplus that cannot be consumed or disposed of in other ways. The preserving process is simple and, although it would not be approved of by a "Department of Health," is apparently adequate for the people concerned. The fish are gutted and cleaned in a primitive way and split in two, crushed salt is well rubbed in, and the fish slung over a bamboo pole to dry in the wind and sun.

Varieties of Salt

The several varieties of salt are generally classified according to color or texture. It is an interesting fact that certain communi-

[1] George Juan and Antonio de Ulloa: A Voyage to South America, 2nd edit., London, 1760, Vol. 1, pp. 175–176 and 178.

ties of the hill people always demand the coarsely crystalline and earth-colored crude salt, a preference which, at first sight, appears to be unusual. According to the director of the mines at Salinas these people insist that such salt has the property to *endulza mas*, that is to say, it *sweetens* more than the other varieties. On the part of the Indian this preference is empirical, but in fact his judgment is more sound than that of the *costaños*, as not only do the finer white varieties of crude salt contain a small proportion of selenite (sulphate of lime) but they also are deficient in the medicinal values of the iron elements that give the brown or earth-colored appearance to the salt itself. Although the government is said to be considering a salt refinery, it is certain that the commodity in this form would be unconditionally rejected by the natives of the interior—and less important causes have provoked political crises.

Localities Producing Salt

With the exception of one or two occurrences inland, where the thermal springs usually associated with volcanism are not infrequently found to contain sodium chloride, the salt of Ecuador is obtained from coastal localities (Fig. 1). By far the greatest amount is mined at Salinas, in the Santa Elena Peninsula, and the following notes are concerned with this place. Table I gives an idea of the average annual yield of salt.

Table I—Production of Salt in Ecuador for the Year 1928

Locality	Amount (1 quintal = 100 lbs.)
Salinas	140,000 quintals
Charapoto	2,250 "
Punta Arenas	10,500 "
Galápagos Islands	5,000 "
Ibarra, etc. (inland)	350 "
Total	158,100 quintals (7,000 ± tons)

Deposits of less importance occur at Payana, an island at the entrance to the Gulf of Guayaquil, and occasional places inland such as Salinas, near Guaranda, and Guapan near Azogues, where there are salt springs.

No doubt there is also a certain traffic in contraband—salt works carried on without the sanction or the knowledge of the government—along the coast, as very often these places are far distant from the recognized centers of commerce and the expense of transportation is prohibitive for the poorer inhabitants.

Climate and Topography

In previous articles on the climate of this part of the world[2] descriptions have been given of the heavy rainy seasons that occurred during the years 1925 and 1926. These abnormal years, apart from their influence upon local geographical features, were especially disastrous to the salt works of Salinas, as the pits were flooded by rain water and it was impossible to recover the crude salt already collected and awaiting transport. Thus there was imminent danger of a salt famine throughout the country and the government had to take the necessary measures and import salt from abroad, a proceeding that at once increased the cost of this essential article and created local disturbances.

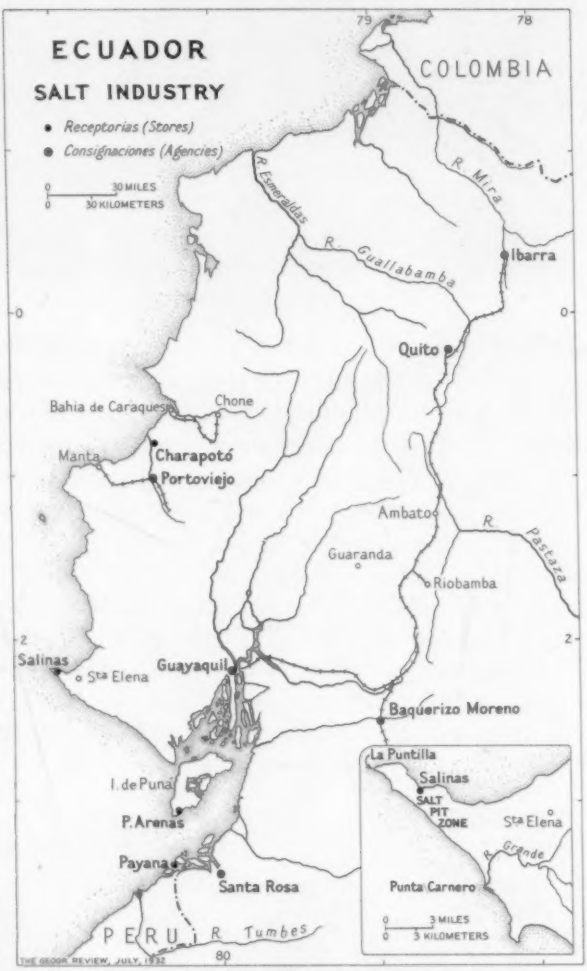


Fig. 1—Map of Ecuador showing the distribution of salt deposits and the organization of the Estanco de Sal. Scale 1:5,000,000. The inset shows the Santa Elena Peninsula and the salt pit zone.

Since those years, however, the authorities have made preparation against climatic eventualities, endeavoring to have at least one year's supply of salt stored in the warehouses as a reserve. Recently a new ferro-concrete storehouse has been built at Salinas.

The salt plains, *salinas*, occur at about the level of high tide, and

[2] R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54.

George Sheppard: Notes on the Climate and Physiography of Southwestern Ecuador, *Geogr. Rev.*, Vol. 20, 1930, pp. 445–453.

FIG. 2—Westerly extremity of La Puntilla, an erosion platform of post-Quaternary emergence.

isolated cases are found below this level, e. g. the salt pit zone of the Santa Elena Peninsula. In a geological sense the salinas are a form of salt marsh, areas abandoned by the sea in comparatively recent times. They are usually represented in this region by Quaternary sea floors, or *tablazos*, resting upon a plane of marine erosion in the Tertiary formations. In many instances the ancient sea cliffs, with their eroded platforms and caves, can be observed at a considerable distance from the present shore line and well above the level of the ocean, evidence of the coastal uplift or emergence that has been in operation from the close of the Quaternary to the present time.

The principal features of geographical interest occurring in this coastal area have been described in previous publications, and the salt zone under discussion is included in the low plain that extends roughly from La Puntilla southeast to Punta Carnero and is sepa-

FIG. 3—General aspect of the salt workings near Salinas, the headland of La Puntilla in the distance.

FIG. 4—Final stage in the crystallization, the salt being heaped into "montones" ready for collection.

rated from the ocean by a well developed sand bar. From the general configuration and relief of this section of the littoral it is clear that at one time it formed part of the ancient estuary of the Rio Grande; and even now the remnant of this watercourse, though shallow and full of meanders, is the largest of its kind in the district. In common with other drainage channels of a similar nature the Rio Grande rarely has flowing water through the normal seasons of scanty rainfall. During the years of heavy precipitation, however, such as 1925 and 1926, these watercourses become raging torrents. On these occasions, which fortunately take place only after certain intervals of years, the estuarine basin is converted into an extensive lagoon, the waters occupying the depression now known as the salt zone being prevented from entering the sea by the sand bar.

FIG. 5—A "contrabandista," an illicit salt working on the coast.

The general low-lying and monotonous aspect of the salt plains, with their ever-present and bewildering mirages, their windstorms, and bush vegetation, is relieved here and there by low hills, outcrops of hard siliceous rock. These ridges or ancient reefs indicate in a general way the natural boundaries of the salt-producing areas. In these semiarid districts the problem of potable water is always present, and the inhabitants have to obtain their supplies from shallow, hand-dug pits near Salinas and at the settlement of Muey. The fact that this water rarely has a salty taste is an indication that the salt obtained from the workings is of superficial origin and has not been leached from subterranean sources of any great depth. By a fortuitous circumstance the water pits mentioned above penetrate the underground water-bearing gravels of the ancient course of the Rio Grande which, at no distant period flowed farther to the west. As a consequence of the rains that fall nearly every year in small quantity, the greater part of the drainage, instead of being carried away by the present river valley, gradually seeps underground, follows the older channel, and ultimately reappears in the water pits of the locality. There are also outcrops of impervious chert rock near the water-pit zone, and it is possible that these rocks form natural barriers that assist in the process of ponding, or temporarily arresting, the movement of the underground waters.

The salt works are distributed over considerable ground, though it is estimated that immense reserves are still untouched and form a source of potential exploitation.

Processes of Mining

The present-day processes of mining the salt are probably the same primitive methods applied a couple of centuries ago; nevertheless they accomplish their purpose, and working costs are reduced to a minimum. Large, shallow, rectangular pits, or pans, about 300 feet by 90 feet and from 4 to 6 feet in depth, are excavated by hand. In no case are the older rocks encountered, the excavations all being in recent marine sands. The Tertiary sandstones and shales, however, do not occur very far below these recent deposits, and it is considered that the colored varieties of salt are due to the incorporation of ferruginous material, leached from the sandstones that not infrequently lie near the base of the reservoirs.

The average depth of the salt pans, or *saladeras*, below high tide mark is some fourteen feet; and, assuming a maximum of ten feet for the tidal interval on this coast, it is clear that the greater part of the immediate region is slightly below the level of the ocean. For this reason the natural processes that have assisted in the segregation of the salt, of which solar evaporation is the most important, are

further simplified by hydrostatic phenomena in conjunction with capillarity and upward filtration. The presence of a more or less permanent salt-water table between the older geological formations and the recent marine sands overlying them also assists materially in saturating the sands from which the mineral is produced.

The depth of water in the pits rarely exceeds ten inches at the beginning of evaporation, and after a few days mineral precipitation begins. When about 93 per cent of the water has evaporated the residual liquid is sufficiently saturated for the precipitation of the sodium chloride. Sulphate of lime is precipitated normally before the ordinary salt, a thin film of selenite forming, in the first instance, at the base of the brine reservoir. This at once impedes the migration of sea water from below. As a consequence the original quantity of sea water in the reservoir is not increased hydrostatically. In the initial stages of evaporation irregular ridges of salt are developed in the shape of rough hexagonal outlines, these often measuring a few feet in breadth. The ridges, beginning under water, gradually emerge and finally become relatively dry as evaporation continues. The general nature of the salt ridges is occasionally modified by ripple marks or by the inclusion of sand particles and crystals of selenite. The time required for the complete removal of the water by solar evaporation in the reservoirs at Salinas varies from two to three months, the interval being governed by local climatic conditions, for example, the prevalence of mists.

The crude salt is collected in a simple manner, the hard crust of salt being broken into blocks of convenient size and made into small heaps, *montones*, which are arranged alongside the reservoirs to await transport to the warehouse. As a rule the salt has a thickness of from one to six inches; and many varieties are especially hard and compact, approaching the consistency of true rock salt. In regard to color the natural tint of the salt when freshly collected is either brown, yellow, or white, the browns and yellows being caused by the presence of minute quantities of iron which were present as compounds in the water at the time of evaporation. No doubt certain of these salt reservoirs have been made near the ancient margins of a lagoon or marsh where vegetation was at one time prolific. This may account in part for the variation in color as well as the local leaching which has been referred to previously. The light-colored salt contains a small admixture of sulphate of lime, presumably collected from the bottom of the pits. The texture or grain of the mineral depends entirely upon the rate of evaporation, the larger crystals taking a longer time to form than the fine-grained varieties. These characteristics depend usually on the intensity of the solar heat in conjunction with the strength of the prevailing winds and the general humidity of the atmosphere.

National Organization of the Salt Resources of Ecuador

The government department, known officially as the Estanco de Sal, has its head office in Quito. The principal collecting stations, or *receptorías*, are located at Salinas, Punta Arenas, Payana, and Charapoto. Distribution is made through the agencies, *consignaciones*, located at Quito, Baquerizo Moreno, Guayaquil, Santa Rosa, Portoviejo, and Ibarra.

Ignoring for a moment the subsidiary *receptorías*, whose production serves the needs of the district only, it can be considered that the *receptoría* at Salinas fulfills the greater part of the national requirements. At this place the salt is packed in sacks each containing a quintal (100 lbs.) and is loaded into sailing vessels that connect with Guayaquil. These boats, in all probability, are much like those belonging to the "merchants of Guayaquil of two hundred tuns," which followed the same business nearly two centuries ago. From Guayaquil the principal distribution takes place, largely through the medium of the Guayaquil and Quito Railway with its subsidiary ramifications, the Quito-Ibarra and the Sibambe-Cuenca (south of Baquerizo Moreno) branch lines. From the railway stations the salt is conveyed by whatever means are available, Ford automobiles, mules, horses, llamas, and Indians; and the author has even seen a large pig ambling along, well "packed" with salt.

ALONG THE LLANOS-ANDES BORDER IN ZAMORA, VENEZUELA*

Raymond E. Crist

SOME of the communities of South America now have a relatively lower position than they enjoyed in colonial days. Such is the state of Zamora in Venezuela, whose capital, Barinas, was once second only to Caracas in size and importance. The prime cause of its backwardness is assuredly the poor state of communications, discouraging alike immigration of foreigners and enterprise on the part of the native inhabitants. Here is a state with an area of 13,500 square miles—larger than Massachusetts and Connecticut—and a population density of only four to the square mile (1926), almost the lowest rank among the Venezuelan states. The roads within the state itself and those connecting it with external centers are practically intransitable in the wet season. The automobile road from Pedraza (Ciudad Bolivia) to Acarigua is open only five months of the year, and even then one may be delayed in fording a flooded stream. From May to November, inclusive, travel in any degree of personal comfort is impossible. Necessary traffic in freight is carried on by pack trains which cross the mountains in the Santo Domingo Valley to connect with the great Transandine highway. A little freight comes in *bongos*, dugout canoes, up the rivers Canaguá, Suripá, and Santo Domingo from the Apure. Mule carts come from Acarigua to Barinas in a week or ten days over water-soaked roads. This shows how necessary is the completion of the road under construction from Acarigua, Portuguesa, to San Cristóbal, Táchira. The number of large rivers to be bridged makes the project particularly costly. Except in a few places, the road, the Carretera Occidental, follows a major physiographic boundary—that between the llanos and the mountains. This interesting border region has been mapped by the author and is shown in Figure 1.[1]

The Llanos

The llanos are about as flat as it is possible for land to be in nature. On the Santo Domingo River from Barinas to Nutrias, a distance

*A vast amount of data has been accumulated by oil companies working in Latin America, but little has been made available. Thanks to the liberal attitude of the Atlantic Refining Company, I have been granted permission to use the geographical data obtained in the course of making an extensive geological survey in the state of Zamora, Venezuela. Special reference must be made to the aid afforded by my immediate chief, Rolf Engleman.

[1] Compare conditions in an Andean border area farther south in F. O. Martin: Explorations in Colombia, *Geogr. Rev.*, Vol. 19, 1929, pp. 621–637.

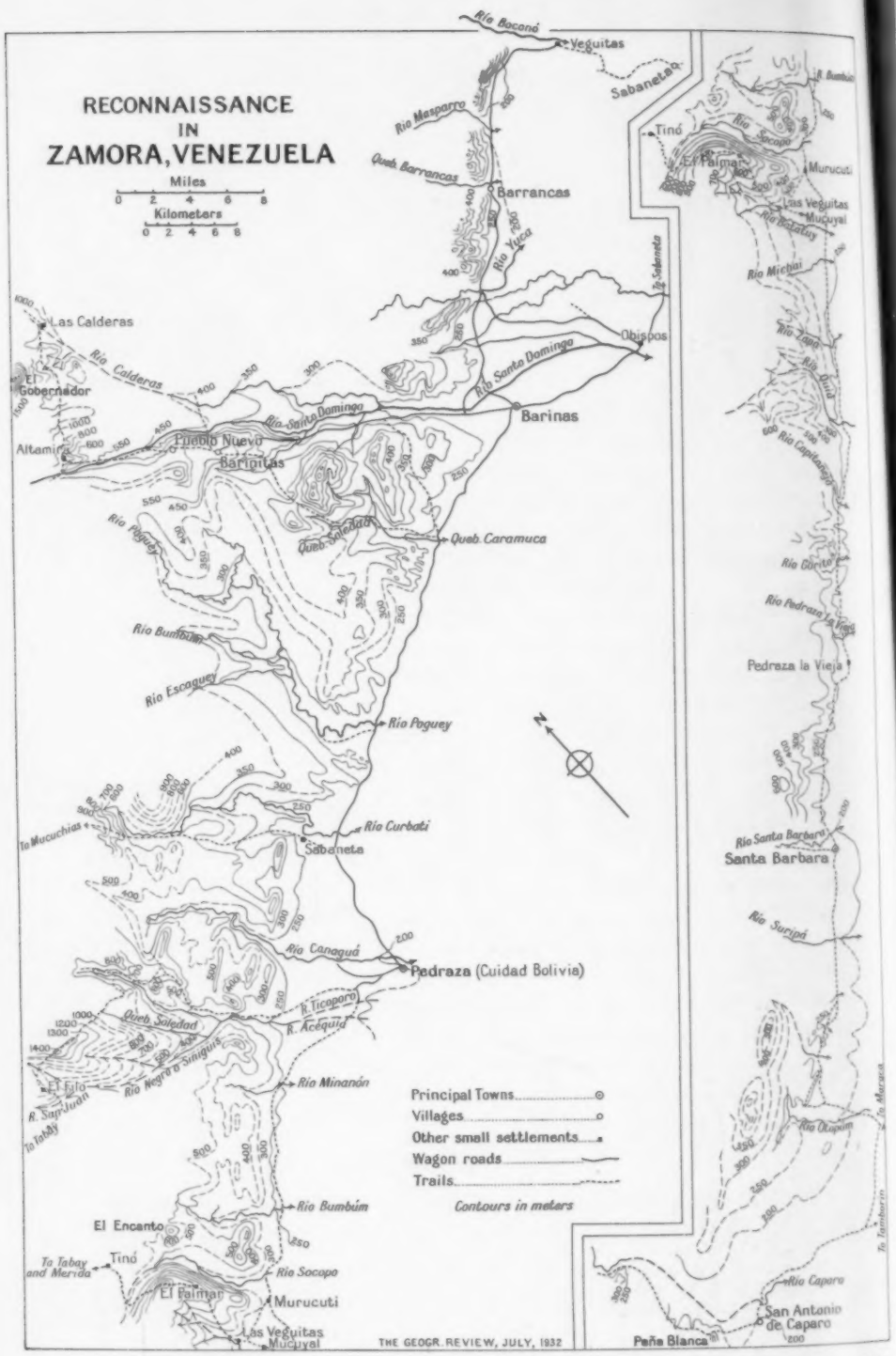


FIG. 1—Reconnaissance map of a part of the state of Zamora, Venezuela, along the Llanos-Andes border. Scale 1:600,000. For the general setting see Figure 2.

of some 115 kilometers by air line, there is, for instance, a fall of only 75 meters. Over a great part of the llanos cars can be driven without difficulty during the dry season of the year, though the usual mode of travel is by horse or mule. These great plains are composed of terrigenous sediments—a vast network of sand and gravel lenses deposited by the overloaded streams in their shifting courses; silts

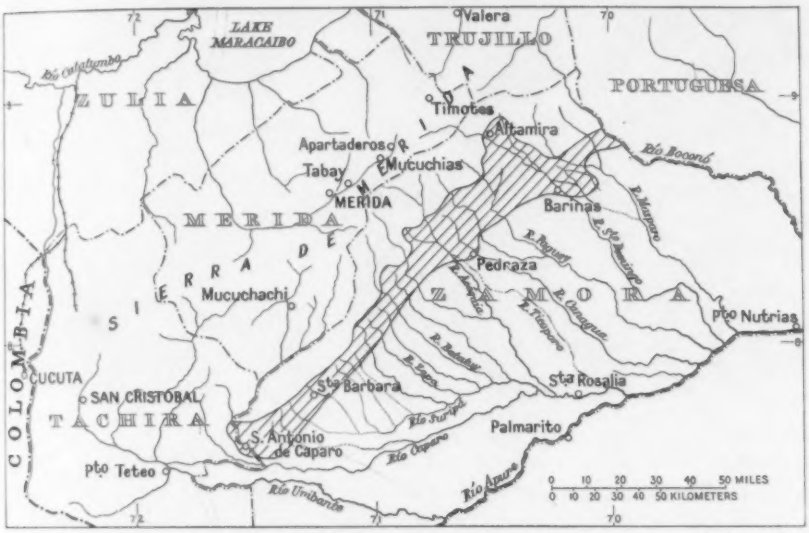


FIG. 2—Map of a part of western Venezuela showing the area mapped in Figure 1. Scale 1:3,500,000.

and clays so abundantly laid down in small permanent lakes and in areas of temporary inundation that one observer has been led to speak of a "post-alpine freshwater transgression."[2]

Annual inundation is still the peculiarly characteristic feature of the western llanos of Venezuela. A rainy season begins more or less definitely in May. May, June, and July are usually the months of heaviest rain with alternating periods of one to two weeks of rain and of sunshine till mid-December. Then the dry season begins, though there may be rains in the mountains that cause the rivers to rise considerably even in January and February. It surprises one traveling for the first time over the sun-baked mirage-dazzled llanos in the dry season to approach a ranch house distant from any stream and see a *bongo* tied to a stake. It is the only means of travel in the rainy season. The ranch houses are commonly situated on the low ridges, *los bancos*, a meter or so higher than the surrounding plains. They form also a retreat for livestock during the rains.

The proportion of permanently dry land increases as one approaches the foothills, where there is more fall and where the thick

[2] Peter Christ: La coupe géologique le long du chemin de Mucuchachí à Santa Barbara dans les Andes Vénézuéliennes, extract from *Eclogae Geologicae Helvetiae*, Vol. 20, 1927, p. 414.

deposits of sand and gravel readily absorb the water that does not drain off the surface. The Quebrada Otopúm and other small streams between it and the Caparo River disappear, as soon as they reach the plains, in what is evidently a deposit of more than ordinary thickness.

In many low-lying flats water remains for a time after the floods subside. These *esteros*, while they last, are the rendezvous of many

FIG. 3—Typical estero landscape toward the end of the dry season, showing *palma llanera*. Llanos southwest from Calabozo. (Courtesy of G. Alvarado.)

kinds of wild fowl that come to feed on the entrapped fish. After they have dried up, the moist soil supports a growth of short tender grass to which the stock repair. At the close of the dry season water remains only in the larger streams and the lagunas, extensive pan-shaped depressions deep enough to penetrate to the water-bearing sands stratum underlying the clayey layer that forms the bottom of practically all esteros.

GRASSLAND AND WOODLAND

The vegetation on the open unwooded llanos is variable. Coarse grass as high as a man flourishes in the moist loamy sections, the *pajonales;* knee-high prairie grass grows in the drier sandy regions. In an occasional estero, which holds water long enough to kill the grass, weeds and a sort of prickly briar obtain. The strips of savana are bordered by gallery forests along the streams. The Spanish word, *cajón*, box, is aptly used in referring to a small savana so bordered on all sides. In some places the savanas are so large that the traveler can see no boundaries of forest; the sky meets the undulating grass on the horizon, the monotony broken only occasionally by a *mata*, or small group of trees.

Between the quantity of rainfall, the ground-water level, and the distance between streams there is, however, a delicate balance determining whether the llanos shall be grass or woodland. Grass-

lands occur where the rivers are far apart, the run-off rapid, and the ground-water level deep. But the boundary between forest and grass is an ever shifting one. The forest is perpetually striving to expand at the expense of the grasslands, and tongue-like strips are pushed out from the gallery forests where and whenever the balance is thrown out of adjustment for a year or so. In Zamora two wooded sections

FIG. 4—Savana fire. On llanos southwest from Barinas.

claim attention—the Suripá or Ticoporo forest[3] and the panhandle of the state east of Nutrias. The nearness of the Cojedes, Guanare, and Apure rivers in eastern Zamora, and the closeness of the ground water to the surface the year round apparently account for the presence of the almost unbroken woodlands in that section of the state.

The Suripá woodlands occupy a great triangle with Santa Barbara, Santa Rosalia, on the lower Suripá River, and Pedraza as the apices. The woodlands seem to owe their existence to the fact that the many large tributaries flowing in the Suripá River from the north are so close together that the gallery forests were able to unite. *Palmares*, or extensive tracts of land supporting only the common *palma llanera* and not dense forest, may exist in the southern part of this section. As it has not been explored and from a plane one cannot tell whether one is flying over dense jungle or palmares, the question remains open. Only on the edges of this great triangle are there any settlements. Its interior is entirely unexplored.

CASES OF RIVER CAPTURE

Some interesting cases of stream piracy in which large rivers of the area play a part may be cited. Three kilometers or so upstream from Barinas the Santo Domingo divides into two streams. The

[3] Compare Wilhelm Sievers: Venezuela, Hamburg, 1888, p. 223.

larger part of the river, called the Caipe, does not again return to its parent stream but flows south of east and joins the Masparro. In spite of this natural diversion of part of its water the Santo Domingo continues to be a threat to the safety of Barinas, and the state government has gone to great expense still further to divert its waters. Not

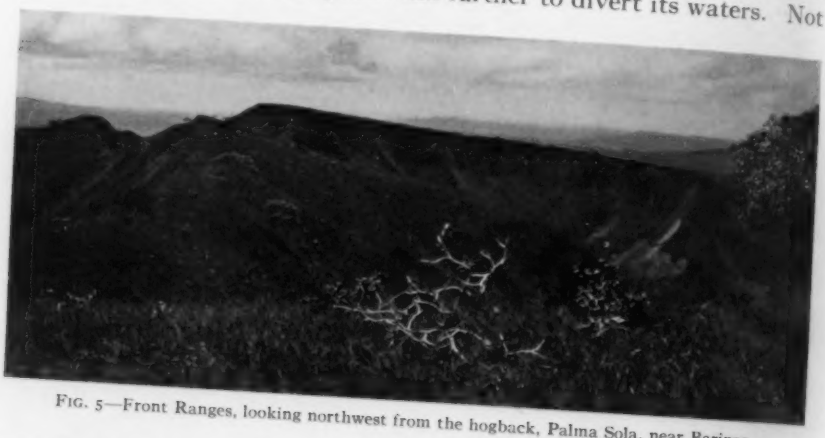


FIG. 5—Front Ranges, looking northwest from the hogback, Palma Sola, near Barinas.

many centuries ago this river flowed in a channel, still quite marked, about a league to the west of Barinas.

Only a few generations ago the waters of the Acéquia River flowed across the llanos in the bed of the present Ticoporo, the present channel then being a mere *caño* which often dried up during the summer. A rancher cut a small canal from the main stream to this caño so that his stock would have a good permanent supply of water. During a rainy season the river cut a permanent channel to this lower level course, and the name Acéquia has since been applied to the whole stream from the Suripá to its mountain headwaters, while the name Ticoporo signifies merely the headless segment that flows out across the llanos.

Not long ago the Caparo River emptied into the Apure less than a league downstream from Palmarito. It has recently straightened its course to almost due east and now flows into the Suripá. This new course is so recent that the gallery forest along it is not everywhere fully developed but is often completely lacking or consists of very young trees and shrubs. The old course is filled with water backed up from the Apure during the rainy season but is otherwise dry. The Uribante also is generally conceded to have altered its course. Like so many other streams of the region it is intensely braided, and water from at least one of its distributaries reaches the Caparo in the extreme southwest corner of Zamora.

M. Reinhard[4] in discussing the Venezuelan llanos suggests that

[4] *Compte Rendu des Séances de la Société de Physique et d'Histoire Naturelle de Genève*, Vol. 39, 1922, p. 14.

these cases of stream piracy may be caused by vertical uplift of the region. However, his observations were made in eastern Venezuela where there was more uplift and compression than in the west. I would propose other solutions. In the case of the rivers Santo Domingo and Acéquia capture takes place very near the mountain

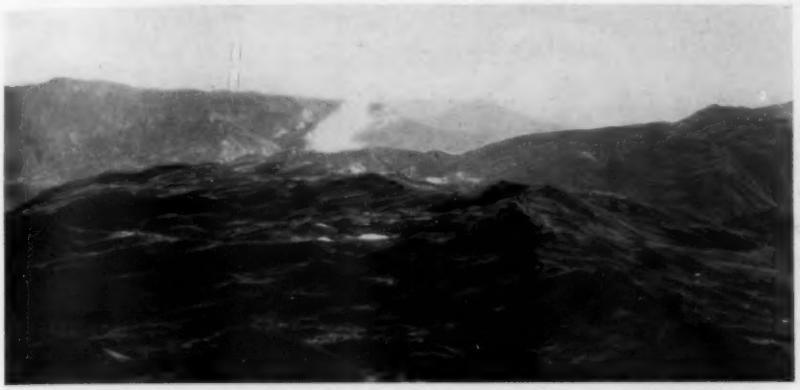


FIG. 6—Glaciated topography in the vicinity of Niquitao. The ridge seen in the left background is the boundary between Zamora and Trujillo. (Courtesy of Dr. Peter Christ.) Only a small part of the state of Zamora is occupied by the high cordillera, the axis of which lies in the state of Trujillo, and in the Teta de Niquitao attains an altitude of 4006 meters.

front where a vast alluvial fan, miles in extent, has been deposited by each. I think it would be quite possible for a fan to develop unduly on one side until the fall was not as great as on the other. Then in time of flood a new bed could readily be channeled out toward the side having more fall. A case in point is the Colorado River, which deposited so much alluvium on the Gulf of California side of its fan that in time of flood it sought the nearer route and the one with most fall, viz. to Salton Sea. Had there been another stream there a case of piracy would have been the result. It should be borne in mind that these fans are very extensive, and, though apparently level, a difference in fall of a meter or more in the kilometer is not uncommon on them between one side and the other. This is considerable for a large river.

I am inclined to account for the change in the courses of the Uribante and Caparo by sinking rather than uplift. According to Peter Christ the most recent movement in the Santa Barbara area is a slight depression with accompanying annual inundation in the low llanos. Streams with almost no fall are wont to choke up their courses with trees and all sorts of débris. When the high water and consequent inundations come, a comparatively slight hindrance in the old bed will send the main current out over the soft, easily eroded plains. In the course of a rainy season a new bed could be formed.

FIG. 7—Panoramic sketch (continued on p. 419) of the terrace system northwest of Barinas.

THE FRONT RANGES

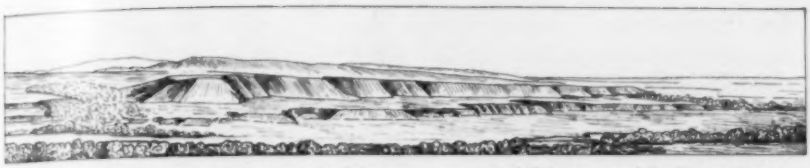
The well defined boundary between the llanos and the mountains in the eastern part of the state is the southeastern scarp of the Front Ranges (Fig. 5). Rising three to four hundred meters above the plain the Front Ranges are a marked feature of the landscape from the Boconó River to the mountain of San Isidro. From San Isidro west to San Antonio de Caparo the line of the Front Ranges is broken. In this latter segment the younger Tertiary deposits are absent (probably downfaulted), while the older and more consolidated Tertiaries form steep prominent ridges.

These ranges, of little significance except as a distinct topographic boundary, are composed of gravels, boulders up to two feet in diameter, and very sandy shale fragments exhibiting only occasional signs of sorting, as one would expect of material laid down by swift mountain streams just at the point of their entrance upon plains where both gradient and volume are in a large degree lost. In their higher parts the mountainward sides of the Front Ranges are vertical cliffs overlooking cirque-like hollows, formed by the headward cutting of intermittent streams. Plainward they have a general slope of from five to ten degrees and are covered in great part with rounded residual boulders of coarse-grained sandstone.

Because they are composed of loose gravelly or sandy deposits, which are quite permeable and dry out readily, the Front Ranges are the home par excellence of *chaparrales*, thickets composed of a heavy growth of *chaparros* (*Curatella americana*, *Byrsonima* var. sp.), and *alcornocos* (*Bowdichia virgilioides* H. B. & K.). Where the chaparrales are lacking, short prairie grass covers the surface wherever it can find a foothold between the boulders.

THE TERRACES OF BARINAS

Of special interest is the remarkable terrace formation around Barinas. This lucidly shows that the foot of the Andes has here only recently, geologically speaking, undergone a slight uplift, the successor of an older uplift of the Front Ranges. These terraces are very beautiful, both from a scientific and an esthetic point of view. (Fig. 7). The villages of Altamira and Pueblo Nuevo and the important town of Barinitas on the river Santo Domingo are all located



Compare this sketch with the photograph of the terrace system of Valera west of the Sierra (Fig. 8).

on well developed terraces two hundred meters or so above the river. Both sides of the cordillera bear equally beautiful and remarkably well preserved terraces; for example in the vicinity of Valera, state of Trujillo (Fig. 8), in the west are terraces matching those of the Santo Domingo region on the east.[5]

The Mountain Province

The tectonic history of the area under discussion has been summarized by Christ[6] in tabular and graphic form on the basis of a geological cross section from Mucuchachí, Mérida, to Santa Barbara. As my own fieldwork did not take me into the higher cordillera where the ancient granitic and metamorphic core is exposed, I shall refer here only to the sedimentaries of the southeastern flank. Little in fact of the former area falls within the state of Zamora, and there are few inhabitants on its barren páramos. Both from the physical and human standpoints the sedimentary mountains are the more interesting.

All parts of this zone bear witness to structural deformation in Tertiary times. The section between the Boconó and Santo Domingo rivers is highly faulted. Between Altamira and Las Calderas the immense tilted block appropriately named El Gobernador dominates the landscape. Most of the disturbed blocks are smaller than El Gobernador and show little system in displacement or amount of upthrow or downthrow.[7] Foraminifera of Eocene age[8] have been found in place in the vicinity of Las Calderas, and sedimentary fragmental material containing Carboniferous fossils is found in some streams. The Santo Domingo River occupies an old line of weakness along which there has been much faulting, and doubtless for this reason the river has cut farther headward than the others draining southeast from the Mérida Range.

The relatively low passes across the cordillera at the head of the Santo Domingo and a tributary, the Apartaderos and Timotes

[5] The origin of these terraces through uplift has been suggested by Christ, *op. cit.*, p. 414. See also Ralph H. Liddle: Outlines of Venezuelan Stratigraphy, *Pan-American Geologist*, Vol. 57, 1932, pp. 161–185.

[6] *Op. cit.*

[7] The best map of this section is that made by Dr. M. M. Knechtel, but it is not yet available for publication.

[8] Marine Eocene Deposits on the East Slope of the Venezuelan Andes, *Bull. Amer. Assn. of Petroleum Geologists*, Vol. 11, 1927, pp. 992–996.

passes, respectively, have from remote times been favorable to trade between the llanos and the Mérida region. On the fertile terraces along this rather easy route fair-sized towns have grown up and serve as way stations for the numerous pack trains.

The section between the Santo Domingo and Acéquia rivers is not so highly faulted. On the right bank of the Curbati River one

FIG. 8—Terrace system southeast of Valera at the junction of the rivers Mototán and Mombay. (Courtesy of Dr. Peter Christ.)

notices a peculiarity of drainage. The Curbaticito parallels it for several kilometers. Drainage is into the Curbaticito rather than into the large master stream till the former empties into the latter. One would be inclined to say that the Curbati also flows along a fault line. On the Canaguá River, east of the village of Santa Catalina, are the Mene seep and the hot spring charged with sulphur.

From the Acéquia River to the Caparo, Santa Barbara is the only settlement that has more than a few houses. The lack of settlements between Pedraza and Santa Barbara is due to the lack of an easy route across the mountains and the paucity of terraces as town sites on the one hand and the nonexistence of cattle lands on the other.

Parties working up the Bumbúm River have not yet reached the metamorphic or granite, whereas less than a kilometer up the Quiú River the contact between sedimentaries and schists is found. Cases of this sort could be multiplied and would show that this section has been the scene of important structural deformations. One of the most impressive single features is the pyramidal Cerro del Encanto visible up the Bumbúm River valley from the trail in the small savana near the river crossing.

NATURAL RESOURCES

The natural resources of Zamora, as the foregoing discussion of land forms suggests, are varied, and the present is no index to produc-

tive potentialities. Probably about one-fourth of the area of the state is in grass and most of the remainder in timber. The grasslands are naturally adapted to grazing. A very good breed of cattle has been developed—large but not bony, with an excellent aptitude for putting on flesh. Very little work is required in tending them except when they are branded as calves and again when separated and driven to the markets. They are driven in herds of three or four hundred over the mountains to supply principally the Mérida and San Cristóbal markets. The Santo Domingo, San Antonio de Caparo, and Guasdualito-Teteo trails are the usual routes. From eastern Zamora some cattle are driven to Barquisimeto and Valencia by way of the Acarigua and Calabozo routes, respectively. The stock now on the llanos is only a small part of their capacity. The great stretch of savana between the Canaquá and Curbati rivers, for example, seems to have almost no cattle at all on it—at least not for thirty or forty kilometers from the road.

The wooded tracts contain many kinds of timber available both for coarse constructional needs and for houses and furniture. Mahogany is found, as well as the large *cedro* (*Cedrela mexicana* Roem.) which has an easily worked, durable wood from which the dugouts are commonly made. The *almacigo* (*Bursera simaruba*) is also found in large quantities. This tree, when tapped, gives forth a sweet-smelling resin which is used as an ointment and is burned for incense.

From the *palma llanera* or *palma de sombrero* (*Copernicia tectorum* Mart.) come the leaves that are universally used for the roofs of houses and the young leaves from which broad-brimmed hats are made. The heavy trunks are used for various building purposes, and the fruit for chicken and hog feed. The leaves of the yagua (*Attalea* var. sp.) are also used for roofing, and its nuts yield a fine oil. The trunk, when tapped, gives forth a sap that soon turns into a fine-tasting potent wine. Nuts from the coco palm (*Cocos nucifera*) and corozo (*Acrocomia sclerocarpa*) are gathered for their rich oil content. The stately samán (*Samanea saman* Mer.) is planted for its shade. The *totumo* (*Crescentia cujete* L.) trees yield the fruits of the same name from whose hard shells all sorts of household articles are made.

In the comparatively heavily wooded section east of Nutrias there are a number of settlements of several houses. The chief occupation is clearing new forest land and raising small patches of corn on old clearings. With the corn raised several thousand hogs are annually fattened, and a great quantity of lard is put up in used gasoline tins and shipped overland to Barquisimeto and Valencia or down the river to Ciudad Bolivar. The soil is moist and fertile; and, as there is no frost to kill, two crops of corn a year can be grown without difficulty.

In the Suripá woodlands cacao grows wild. Cultivated it would yield enormously. In colonial days the cacao and tobacco from

Barinas and Pedraza were considered the best in Venezuela, but the latter is little grown now, and only enough of the former is gathered for local use. The word *Varinas*, incorporated in the German language and signifying a good brand of tobacco, testifies to the former wide renown of the Barinas product. Delicious oranges are grown in Pedraza; yet there are comparatively few trees there, and no attempt at all is made to form large orchards. Near the most important towns, Barinas, Pedraza (Ciudad Bolivia), Santa Barbara, Sabaneta, and Puerto Nutrias, corn, rice, yuca, and bananas are the main crops.

The towns of Altamira, Las Calderas, and Barinitas are the most important ones in the mountainous area. The crops that to a great extent sustain their populations are beans, potatoes, yuca, and cane. Coffee is the export crop.

There are excellent sites at narrow parts of the great rivers—this is particularly true of the Santo Domingo near Altamira—where dams could be constructed to furnish power. Tanneries for curing cow and alligator hides could do a great business in supplying the home markets with good leather, which now must be imported.

But the rich resources of grassland and forest, of plain and mountain will not be realized until the transportation problem, the common problem of so much of South America, is solved.

THE SIERRA NEVADA DE COCUY

Frank B. Notestein and Robert E. King

FIG. 1—The summit of Alto Ritacuva, elevation 5493 meters, sketched from a photograph.

Most of the snow-capped summits in the Colombian Andes are ranged along the volcanic summit of the Cordillera Central, which is a northern continuation of the chain of snow peaks of Ecuador. Along that axis the culminating points are Chiles, Cumbal, Puracé, Huila, Tolima, and Ruiz, whose altitudes have been variously estimated as between 4700 and 5700 meters. Far to the north on the Atlantic coast is the isolated summit of Santa Marta, whose elevation was determined by de Brettes as 5887 meters.[1] Three summits on the Cordillera Oriental rise above permanent snow line. South of Bogotá is the Nevado de Sumapaz, which rises above 4500 meters.[2] Between the cities of Pamplona and Bucaramanga lies the Mesa Colorada, stated to reach 4400 meters and to be streaked with snow. The culminating group of peaks of the cordillera, however, is the Sierra Nevada de Cocuy, 275 kilometers northeast of Bogotá, whose summit was determined by the writers as 5493 meters (Figs. 1 and 2).

Approach to the Region

During part of September, 1930, the writers had occasion to visit the Sierra Nevada de Cocuy in connection with some stratigraphic measurements and took advantage of the opportunity to triangulate the peaks roughly and make notes on topography and glaciation.

The name of the range is derived from the town of Cocuy, situated about twenty kilometers to the west. The name "Cocuy" is probably taken from the Spanish word for firefly. The terms Sierra Nevada de Chita and de Güican are much in use for the snow peaks; in fact, the name "Chita" seems to be the most commonly employed. It is probably derived from the name of the Indian tribe of Chitareros, which originally lived in the neighborhood.

The town of Cocuy is reached from Bogotá and other main routes of travel from Soatá, one day by automobile from the capital. From Soatá a trail leads across the deep, parched gorge of the Río Chica-

[1] Griffith Taylor: Settlement Zones of the Sierra Nevada de Santa Marta, Colombia, *Geogr. Rev.*, Vol. 21, 1931, pp. 539–558.

[2] F. O. Martin: Explorations in Colombia, *Geogr. Rev.*, Vol. 19, 1929, pp. 621–637.

mocha to the towns of Boavita and Ubita on the eastern side in a green fold of the mountains. From Ubita there is a steep ascent to a broad páramo (Fig. 4), which is crossed at about 4000 meters, then a descent to the valley of Cocuy (Fig. 3). The trip from Soatá

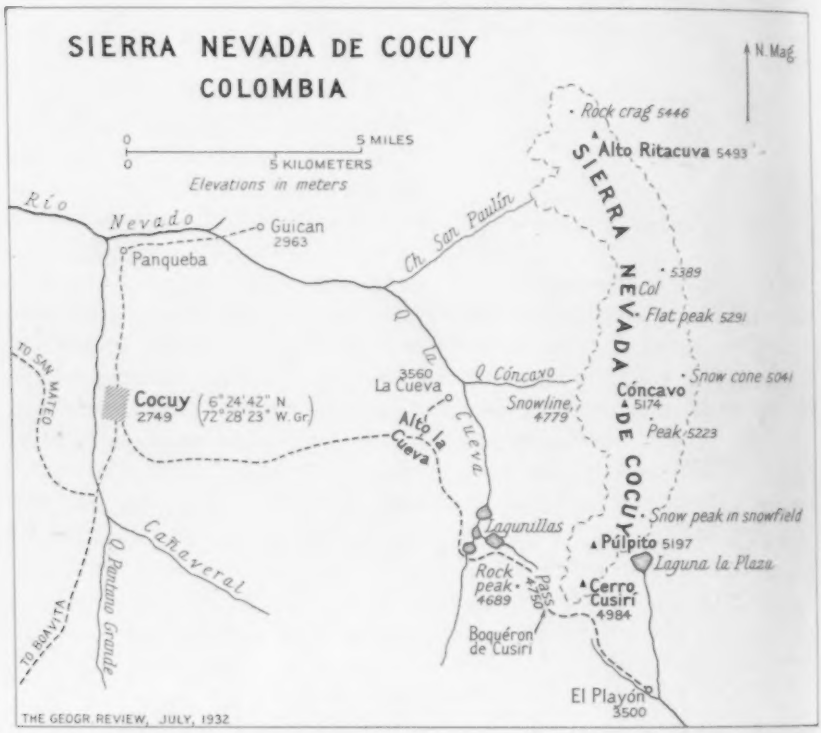


FIG. 2—Sketch map of the Sierra Nevada de Cocuy, department of Boyacá, Colombia. Vertical angles for the elevations taken from a stadia-measured base line: the position of Cocuy is according to the Oficina de Longitudes, Bogotá. Scale of map 1:250,000.

to Cocuy may be made in a day on muleback. From Cocuy there are trails to the south to Chita and Salina de Chita to the southeast in the valley of the Casanare, the latter a journey of about eighteen hours, of which twelve are across barren páramo and the remaining six a disagreeable descent of over 2000 meters by steep zigzags. From the Salina there is a trail to the llanos of Casanare.

Formerly the Cusirí trail, constructed in the nineties at considerable expense, passed over the south shoulder of the snow range (Boquerón de Cusirí) to descend to Lope on the llanos. It was abandoned during the revolution of 1899–1902 but is now being reopened for mule traffic. In 1930 we found it overgrown, the bridges out, and all but impassable below tree line on the eastern slope. Several decades previous there existed a trail from Büicán, northeast of Cocuy (see Fig. 2), to some Tunebo villages on the eastern slope

of the cordillera and from there to Macaguan on the edge of the llanos. This was known as the Camino de Concepción. It has not been used for many years.

Western and Eastern Slopes Compared

The western slope of the Cocuy range has a typical Andean rain-shadow climate with grassy slopes, wind-swept páramos, and

Fig. 3—The town of Cocuy as seen from the south; note mud-walled fields in foreground.

patches of scrubby timber in the sheltered pockets. Such patches of timber exist as high as 4360 meters (aneroid elevation), where the *palo colorado* grows in scrubby thickets in the lee of cliffs. The rainfall on this slope is not heavy, but a rainy season of long duration, April to October, keeps evaporation low. On the lower slopes around the town of Cocuy (2750 meters) wheat, barley, peas, and alfalfa are among the chief products. Irrigation is practiced on a small scale. Groves of eucalyptus have been planted about the town. The mean annual temperature of Cocuy is about 13.2° C. Wheat is grown up to around 3700 meters, and excellent potatoes and onions are produced up to 4200 meters. Sheep are grazed in some places as high as 4500 meters. Owing to the shelter which the range offers against the northeast trade winds, these páramos are not as bleak as those of many other parts of the Cordillera Oriental at even lower elevations.

The crestal portion of the range is formed by a west-dipping mass of quartzite, named by Hettner the Cocuy formation.[3] The westward slopes are comparatively gentle; a huge escarpment faces the east. The abrupt eastern slope catches the full force of the prevailing northeasterlies sweeping across the llanos. No figures on precipitation

[3] Alfred Hettner: Die Kordillere von Bogotá, *Petermanns Mitt. Ergänzungsheft No. 104*, 1892.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—House of frailejones stems in páramo between Cocuy and Ubita. Crossing the foreground is the main trail from Soatá to Cocuy.

FIG. 5—Frailejones in the páramo between Cocuy and Ubita, elevation about 3900 meters.

FIG. 6—Glacially eroded valley of the quebrada draining east from the Boquerón de Cusirí.

are available; but, judging by vegetation and by a few days' unhappy sojourn, this is one of the world's wet spots. It reminds one of the Cherapunji escarpment of Assam. The range was crossed at the south end by the Cusirí trail which was followed as far as the Río Mortiñal, but owing to persistent mists and rain very little was seen of the eastern slope above an elevation of 3600 meters.

Tree line lies at 3000–3200 meters, depending on local air currents. The high-altitude forest is characterized by an abundance of plants that feed on the mists, the trees bearing epiphytes on their trunks and having festoons of mosses. A common plant in this belt is a slender-stemmed bamboo known as *chusque* (*Chusquea scandens*). Below tree line the whole slope of the range is clothed in dense montaña.

Above tree line are a few huts where a hardy population eke out a miserable existence from their cattle and small patches of potatoes. Below tree

line there are a few clearings, especially on high terraces, which are stocked with cattle. North of the Mortiñal the eastern slope is practically a *terra incognita*. Representation of the drainage in that region on published maps is certainly inaccurate, but explora-

FIG. 7—View northeast from the saddle near the summit of Ritacuva. On the right is a deep cirque valley, and on the left a high rock crag, whose elevation is 5446 meters. In the distance is a lower range, which rises between the Nevada de Cocuy and the llanos. Drawn from photographs.

tion is made difficult by the high relief, the heavy forest cover, and the unfriendly nature of the Tunebo tribes.

THE SNOWY SUMMITS

The Sierra Nevada de Cocuy is about seventeen kilometers long from north to south (Fig. 2). At the south end of the snow-covered range is the Boquerón de Cusirí (Cusirí Pass), elevation 4750 meters. At this point the old Cusirí trail crosses the range. During the rainy season the pass is snow-covered although rarely closed. Just east of the pass stands Cerro Cusirí, elevation 4984 meters. This lone minor peak is snow-capped but not ice-clad. It is separated from Púlpito by a round-bottomed cirque valley draining southeast.

El Púlpito, elevation over 5197 meters, is commonly regarded as the highest peak of the range, as it rises prominently at the southern end close to the Cusirí trail and close to settled areas; but it is really lower than the less striking northern peaks. The actual summit of El Púlpito is not visible from the west side. It is an eastward-facing cliff capped by probably a hundred meters of solid ice. West of it and slightly lower is a sharp ice peak on which the above elevation was taken. Northwest of it and still lower is a large rectangular block of rock from which the peak presumably derives its name. The cliff forming the east face of Cerro Púlpito drops off to a cirque valley which contains the small Laguna la Plaza.

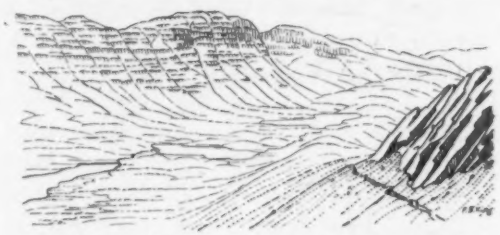


FIG. 8—Lagunillas: morainal-dammed lakes west of Cerro Cusirí, as seen from the east, near Boquerón de Cusirí.

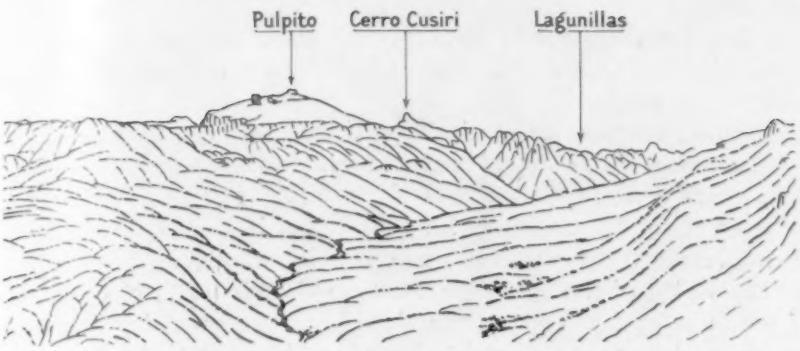
The summit of the

FIG. 9—Panorama of the west side of the Sierra Nevada de Cocuy from the Alto la Cueva. The dotted line on Ritacuva indicates the position of an old terminal moraine.

range swings eastward from Púlpito, and three kilometers of snow fields with some peaks there were mostly concealed from our point of view behind a spur extending north from El Púlpito. The range then swings north and west and rises to the Cóncavo group. El Cóncavo peak, elevation 5174 meters, rises directly above the bare rock slopes of the valley to the west. The lower limit of permanent snow on this west face is at 4780 meters. Glaciers at the heads of the various valleys probably extend considerably lower. The snow and ice on this west slope are clearly in retreat, as a distinct low moraine lies below the snow line. East of Cóncavo peak is a long, high, ice-capped ridge. A conical point southeast of Cóncavo appears to be slightly higher, but mists made accurate measurement impossible.

North of the Cóncavo group for about three kilometers there is a lower snow-field area partly hidden behind a rocky spur to the west. Several small glaciers appear to head in this portion. At its northern end a long glacier tongue extends down into the valley of the Chorreón de San Paulín. The ice front is retreating as indicated by a bare-rock, pond-strewn gap between the ice front and the very regular moraine. At the head of this basin a small rock projects from the highest part of the ice cap.

North of these snow fields rises the Alto Ritacuva, 5493 meters, the highest point of the range. The ice cap covering the narrow ridge forming the approach to the summit bears evidence of being severely crevassed, although these crevasses were filled with sagging masses of snow when we saw them in the rainy season. The ice capping the westward dip slope of Ritacuva extends down westward into a broad morainal V; but, again, the ice has retreated from the inner margin of the moraine. To the east of the Alto Ritacuva the range breaks down in cirque valleys walled with sheer cliffs hundreds of meters high. About a kilometer and a half northwest of Ritacuva, but separated from it by a deep cirque, rises a very striking rock peak, elevation 5446 meters, having no name so far as we could learn, which



The high peaks on the sky line (left blank in the drawing) are covered by snow. The valley of Quebrada Lagunillas (compare Fig. 8) in the foreground. Drawn from photographs.

offers a challenge to anyone having the time and technique for a difficult and dangerous although rather short climb (Fig. 7).

North of the Ritacuva group the range drops below the permanent snow line within a few kilometers. The Magdalena-Orinoco divide trends northwestward, and the drainage northeast of this divide falls into the upper tributaries of the Río Arauca, probably chiefly into the Río Cobaria.

Glacial History

Glaciation appears to have been very extensive during the Pleistocene, as indicated by widespread ice-polishing, but of short duration as indicated by the limited depth and extent of ice-cut gorges (Fig. 6). The lower limit of Pleistocene ice on the west slope is marked by terminal moraines below the junction of the Chorreón San Paulín and the Quebrada la Cueva at an elevation of about 3200 meters. Numerous regular moraines, marking stages of ice retreat, are found above that; but one sees no evidence of repeated advance and retreat of the ice, such as occur in the Rockies and Himalayas. The moraines show surprisingly little evidence of dissection. In the valleys the main quebradas cross one morainal dam after another by cascades, meandering across the flat between. The ponds of Lagunillas (Fig. 8) west of the Boquerón de Cusirí are dammed by moraines. The suggestion is strong that there was one long Pleistocene advance of the ice followed by a fairly steady retreat which is still in progress. From this it may be inferred that the range did not attain an elevation great enough for glaciation until near the end of the Pleistocene.[4]

The living glaciers that we had the best opportunity to examine were those on the westward dip slopes of Alto Ritacuva, Cerro Cóncavo, and Cerro Púlpito. Unfortunately, time did not permit us to

[4] E. T. Apfel (Preliminary List of Titles and Abstracts of Papers to be Offered at the Forty-Fourth Annual Meeting, Geological Society of America, p. 42) reports evidence in the Sierra Nevada de Mérida of an earlier glaciation at lower levels than were affected by the last glaciation.

examine the undoubtedly larger valley glaciers at the head of the Chorreón San Paulín and Quebrada Cóncavo and on the eastern slope of the range.

Besides areas actually glaciated there are large sections of the páramos showing no actual ice effects where there are broad marshy flats, small ponds, and evidences of landslip. They may be the result of some action by the heavy *névé* cover that in the Pleistocene must have overlain the páramos where actual glaciation did not take place. In the valley of the Quebrada Pantano Grande south of Cocuy, at elevations of 3700 to 4000 meters, these features are well demonstrated. Mastodon bones are reported to have been found in that valley.

The Range as a Field for Alpinism

On September 12 we made an attempt to reach the summit of the Alto Ritacuva, starting at four in the morning from a base camp close to 4250 meters west of the ice tongue on that peak. By seven we reached the north shoulder of the summit and could look down upon the llanos, covered with fleecy clouds. Far to the northeast we saw the snowy summits of the Mérida range, the only snow-capped peaks of the Venezuelan Andes. It was impossible to continue our ascent to the actual summit (Fig. 1), about 125 meters above, however, owing to the onset of a violent storm. The last 100 meters would have involved some step cutting and taken time. Half an hour after our retreat the whole upper part of the range was obscured in a howling storm which lasted for three days.

This range offers several good climbs for anyone interested in alpinism. Cerro Púlpito was climbed in 1928 by a party of Germans from Bogotá,[5] but the other peaks are thought to be virgin. Probably none would be particularly difficult except the crag at the north end, already mentioned, if approached from the west: any one of them would probably be difficult from the east side. Good weather may be anticipated from December first to April first, but the rest of the year is likely to be beset with storms.

[5] Walter Röthlisberger: Cocuy: Erste Besteigung, *Die Alpen*, Bern, Vol. 5, 1929, pp. 161–168.

THE TWIN CITY DISTRICT
A UNIQUE FORM OF URBAN LANDSCAPE

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University of Minnesota

THE cultural landscape of the St. Paul-Minneapolis urban district presents a picture of almost unique character. Multi-urban districts are, of course, fairly common; but the peculiar character of the Twin City district is the type of "twinning" found there, that of two almost complete cities separated, not merely politically but geographically, and yet in close contact with each other along one common zone.

The situation is radically different from that of other urban districts that may appear similar on small-scale maps. Particularly is it to be distinguished from that found at many pairs of river towns facing each other—each with, perhaps, half a commercial core—across a dividing stream, for example Omaha-Council Bluffs. St. Paul and Minneapolis each lie on both sides of the Mississippi, the latter being fifteen miles upstream from the former (Fig. 1). Likewise the situation is different from that in which one dominant city is bordered by one or more subordinate cities, with commercial cores only partially developed or even atrophied; for example New York-Jersey City. Manhattan, to be sure, presents the unusual feature of two separated cores of skyscraper districts within a single city, but these are definitely differentiated in form and function, being in fact merely separated portions of an original unit core. Finally, the connection between the Twin Cities is not merely that of an arterial highway built up as a ribbon of urban form across the separating rural landscape, as Bethlehem-Allentown, Pa., or, perhaps, Dallas-Fort Worth, Tex. Rather, it is a connection through a common zone, perhaps half a mile wide.

Functional Independence of the Two Cities

Another peculiar characteristic usually overlooked, even by the residents of the district, is the lack of *differentiation* and *integration* of the two cities. Comparatively few functions are developed in either city to serve both. No doubt the striking differences in the general character and layout of the two cultural landscapes are misleading, for they are due largely to differences in the natural landscape. It is also true that certain of the most striking cultural features of the

one city are not found in the other—the state capitol in St. Paul, the state university in Minneapolis, for instance. In common with the situation at other trade centers of the interior United States, the packing plants are all located within a short distance of a single union stockyard, which happens to be in South St. Paul, an industrial suburb of St. Paul; but the ruins of an abortive attempt to develop an independent stockyard are to be found on the outskirts of Minneapolis. More significant are the towering grain elevators and flour mills which form so dominant a feature of the landscape of Minneapolis but so small a part of that of St. Paul and have their origin in the presence of the Falls of St. Anthony within the former. Certain other minor distinctions could be traced back to significant differences in early environment, such as the greater importance of lumber mills in the upstream, "falls" city, and the concentration of fur-goods plants in St. Paul, the site of the early fur-trading posts.

But a very much greater number of important features are common to both cities. Of the railroads that form the largest activity of the district, nearly all have terminal yards and stations in both cities, and car shops are important in both. There is like variety in the factories, warehouses, and jobbing houses of the two cities; and each has the commercial core, common to American cities of their size, containing all of the "nuclear features"—large department stores, tall office and newspaper buildings, large hotels, theaters, and auditoriums.

The functional independence of the two centers can be observed in the comparatively minor amount of intercity street traffic. Though a single street-car company serves both cities, only four car lines cross the boundary between the two. By street car and automobile this is daily crossed by university students and by a considerable number of factory workers whose residence and place of work are both in the zone more or less common to the two cities lying on both sides of the boundary. From this same marginal zone there is even some crossing of shoppers to the commercial core of the other city, but otherwise comparatively few people are accustomed to shop in both cities; and theatrical performances of all kinds are nearly always duplicated in the two, as though they were a hundred miles apart.

The "Midway" Zone of Contact

That the Twin Cities are not to be considered as completely separate can be seen by a study of the zone of contact. Even before the built-up portions of the two cities had grown together the patterns of the roads and railroads showed the effect of their proximity. There is a marked concentration of all routes to the east and southeast from Minneapolis along a few lines leading through the center of St. Paul.

and vice versa. This has tended to limit the area of rural and small-town territory tributary to each of the two shopping centers to little more than a semicircular belt.

A district that may properly be thought of as common to both centers, though politically included in St. Paul, lies where the three

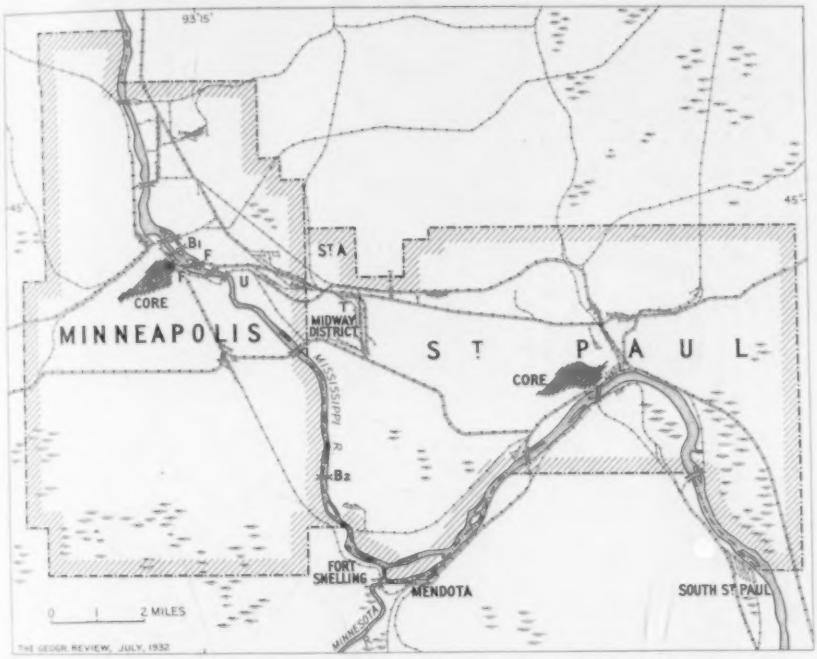

FIG. 1—The Twin Cities, showing political limits, the commercial cores, Midway District, railways, and some sites of early importance. (Marshy areas are shown; for the relation to other surface forms see the U. S. G. S. Topographic sheets Minneapolis, St. Paul, Anoka, and White Bear quadrangles.) B_1, site of first bridge over the Mississippi connecting Minneapolis, then limited to the west bank, with St. Anthony (St. A.) on the east; F-F, Falls of St. Anthony; U, state university; T, transfer yards; B_2, intercity bridge; L, river levee at St. Paul.

rail routes connecting the cities approach each other (Fig. 1), probably because of the relation of certain minor morainic hills to the course of the Mississippi. This is a common point of transfer and is the only one used by all the roads. It serves to tie the two centers into a unit—though double—rail center. Around the transfer yards has developed the "Midway District" of factories and warehouses and blocks of workers' residences.

On the low morainic hills just north of the Midway District is a residential district (St. Anthony Park), also a part of political St. Paul that has close relations with Minneapolis. A short distance south of the Midway District the boundary line between the two cities reaches the Mississippi River and follows that to the southern limits of Minneapolis. Until recent decades this part of the river was undeveloped on either bank, being relatively remote from both

FIG. 2

FIG. 3

FIG. 2—The commercial core of St. Paul, looking west from the river front. Note the terrace bluff which descends in the center foreground to the site of the original boat landing. (Photograph by J. E. Quigley.)

FIG. 3—Looking east over the central part of St. Paul. Note the flood plain on the right bank of the river, the steep bluffs on the left, and the concentration of rail lines in the small tributary valley in the left background. (Photograph by J. E. Quigley.)

FIG. 4

FIG. 5

FIG. 4—Looking south towards the commercial core of Minneapolis. Part of Nicollet Island and the Falls of St. Anthony in the foreground. Beyond the Falls appears part of the milling district; railway passenger terminals in the center and right foreground. (Photograph by Harry Poague.)

FIG. 5—The Falls of St. Anthony and the milling district with the commercial core of Minneapolis in the background, looking west. (Photograph by Harry Poague.)

city centers. It is now used for parks and fine residences; and, since there has been, until very recently, but a single bridge in a six-mile stretch, each side was effectively cut off from the city on the other. An important exception has developed near the southern end of the boundary zone, where industrial advantage has been taken of a federal power dam and where a new intercity bridge has been built.

Psychological Attitude

If the cultural landscape of the district reflects rather the separate independent character of the two centers within it, this is also true to a marked degree of the psychology of the citizens—a fact not without geographic results. The early violent animosity of the period of struggle for supremacy has passed with the recognition of Minneapolis as definitely the larger city (the census of 1930 gives Minneapolis, 464,350; St. Paul, 271,600); but there remains very keen rivalry, by no means always friendly. This situation is reflected in, if not encouraged by, the newspapers, which have very little intercity circulation outside of the zone of contact.

Such attitudes have combined with the political separation—both city and county—to prevent almost every kind of coöperative development. One city complains that gangsters operate within its limits but reside unquestioned in the other. At times of epidemics, the health authorities of each city act as independently as would those of Philadelphia and New York. Even the two city planning boards have no mutual relations. With the exception of two bridges, no public buildings or parks of any kind have been constructed jointly for the use of residents of both cities. Only the pressing problem of sewage disposal in a common river makes necessary a common system, but even here the cities have not yet been able to agree.

Early Period of Settlement

The origins of this well-nigh unique situation are to be found in the early period of settlement, but its present development must be studied in relation to the structure of the all-important city-building factor of the region—the railroads.

In the period of settlement the various attractions found near the junction of the Minnesota and Mississippi rivers led to the starting of at least five different nuclei within a circle of about twelve miles diameter. This is a common enough happening. In the early days of Chicago small settlements were made at the mouths of both the Chicago and Calumet rivers about ten miles apart, and it was by no means certain then which of the two would ultimately become the dominant city. Likewise, near the great easterly bend in the Missouri River were started the settlements of Independence, West-

port, and Franklin—all ignorant of their future absorption by the as yet unfounded Kansas City, while farther upstream Atchison, St. Joseph, and Fort Leavenworth all started more promisingly.

The first white settlement in the Twin City District was the frontier post of Fort Snelling, located in 1819 on the commanding bluff overlooking the junction of the rivers (Fig. 1). On the terrace in the opposite bluff with the protection of the fort just across the Minnesota, the first fur-trading post was established. Around it developed the village of Mendota with every hope of becoming the regional center of the future. Later, about 1840, another post and accompanying settlement was located a few miles downstream at the northernmost point of the Minnesota-Mississippi Valley and called St. Paul. Promptly after the land at the Falls of St. Anthony was opened for settlement two communities started there—St. Anthony on the east bank (1848) and Minneapolis on the west (1853).

At the opening of the rail era, 1862, Fort Snelling had been reduced to a purely military post; Mendota had been practically eliminated from the race; and St. Anthony and Minneapolis were soon to combine (1872) under the name of the latter. But the unusual feature of this district was already showing itself in the survival of *two* competing centers of nearly equal strength, St. Paul with a population of ten thousand and Minneapolis–St. Anthony with six thousand.

Influence of the Railroads

The two towns were, however, still widely separated. Their development into a conurbation resulted only from their rapid growth in the following period as metropolitan centers of their region. Their leading position was not assured in 1860 merely because they were then the two largest towns in the state. The conversion of this particular pair of towns with a total population of 16,000 into a metropolitan district of three-quarters of a million in 1930 was based largely on the establishment of that district in the period of rail construction as the one all-important focus of rail lines of the central northwest. This may be readily seen from a brief analysis of the external functions of the urban district. In any city these tend to be obscured somewhat by the large number of functions developed to serve simply the residents of the city itself. In Minneapolis-St. Paul the "internal" functions employed, in 1919, more than half the total number of men workers. Of the remainder, the railroads, including their car shops, employed more than a fourth—by far the largest single group. The remaining three-fourths were largely employed in activities commonly found concentrated at regional rail centers; flour mills and grain elevators, stockyards and packing plants, warehouses and jobbing houses, foundries, etc.

The growth of the two metropolitan centers in the place of one was then dependent on the development of two complete rail centers for the common region. Likewise the continuance of the two independent nuclei, or commercial cores, depended upon the maintenance of continued independence of the two rail centers, at least in passenger traffic. If the railroads had been in a position to discriminate constantly in their passenger service in favor of one of the cities, as is done at Kansas City, for example, where almost no express trains stop at Kansas City, Kan., that would no doubt have had a marked effect on the commercial cores. With passenger terminals early located at both centers and two cores developing at an almost equal pace, ten miles apart, each was too far from the other to be in any serious danger of submergence or even subordination. Only greatly increased speed of urban transportation could threaten the situation. To a minor extent the automobile has done that.

For an understanding of the railway structure of the district one must, however, examine the rail routes of the central northwest as a whole. Foremost, historically, was the importance of the district as the northwestern terminus of ordinary steamboat navigation on the Mississippi. This was the main route, not only to the south but also to the southeast and east, over river-and-rail routes and even river-rail-and-lake routes through Chicago. Various lines were planned and some built, leading away from the head of navigation north and west and also northeast to connect with the nearest point on the Great Lakes at Duluth. The district also included the termini of the much less important traffic on the upper Mississippi,[1] above the falls, and on the Minnesota. Stillwater, on the St. Croix, was a similar river terminus; but its location farther to the east proved an obvious disadvantage after the opening up of the rich grain area to the northwest.

While affording an early route of transportation, the Mississippi with its valley has been of more permanent importance as a barrier to rail transportation across it. In the morainic plains that extend south and west of the Great Lakes this wide moat-like valley furnished the only serious obstacle to easy rail movement. Formed originally by the outlet of glacial Lake Agassiz, it is now partially filled by the Minnesota River and by the Mississippi below their junction. It involves a belt, one to five miles wide, of river and marsh and low flood plain, bordered on both sides by steep bluffs 120 feet high. Across the southern part of the state of Minnesota the valley cuts a great arch from west to east, convex to the north. Below the junction of the Minnesota with the greater water volume of the upper Mississippi, the barrier is strengthened by the minor difficulty

[1] "Upper Mississippi" refers throughout this article to the river above its junction with the Minnesota, a youthful, largely post-glacial valley much smaller than that of the Minnesota.

of bridging the river itself. To the lines following the dominant direction of travel of the region—northwest to southeast—the Minnesota-Mississippi Valley presents a barrier that must be crossed twice unless they pass around the north of it. At the same time the valley afforded an unusually easy grade to lines following it, though the problem of flood water had to be met, and the river towns were tapped in competition with the steamers.

Why Not a Single Rail Center?

But why did not a single rail center arise? The advantages of situation applied in a general way to the entire district, including all the separate communities within it. If they could have been concentrated at any one of several communities, even though one of the smaller ones, that one might well have developed into a single dominant city and ultimately have overwhelmed the others, as apparently took place at Kansas City. Certain advantages, however, were found to a higher degree at one point; certain others to a higher degree at a second.

One of these points is found on the north bank of the Mississippi on the outside of its great bend where the town of St. Paul had developed (Fig. 1). This was commonly taken as the head of navigation on the Mississippi, for though it was possible for the steamers to go fifteen miles farther, there were shallows between this point and Mendota and Fort Snelling and very difficult rapids in the gorge above. In any case the passage of this difficult fifteen-mile stretch brought the steamers only ten miles farther in a direct line, owing to the circuitous route of the river; and the trip was seldom made, usually only to handle a large consignment of flour. Furthermore, the break in the river bluff at this point caused by the entry of a small tributary stream afforded the easiest place to reach the river from the upland level; and the wide terrace offered, at that period, sufficient land above the flood level for port and city buildings (Fig. 2).

This same point, where the river steamers docked, was also the exact northern limit of the Minnesota-Mississippi Valley, where rail lines passing around that barrier might be expected to meet the intersecting lines following its two limbs and furthermore where utilizable breaks occurred in the bluffs. The easterly of the two small valleys that together join the main valley just below the river levee at St. Paul cuts a narrow ravine in the bluff and provides room for but one double track line. The other, however, thanks probably to its glacial origin, was much wider and with some artificial widening has been used to conduct four main rail lines out of the valley branching on the upland into routes west, northwest, north, northeast, east, and even southeast. Other than the lines that enter the district by

following the main valley itself, all but one of the important lines at St. Paul utilize these two small valleys (Fig. 3).

The other critical place is found where the presence of Nicollet Island offered the easiest crossing of the upper Mississippi for the routes which pass north around the glacial Minnesota-Mississippi Valley (Fig. 1). Originally utilized as a road crossing by one short bridge and a ferry, this point later (1855) boasted the first bridge of any kind across the Mississippi and became the center of roads leading into the country to the west (Fig. 4). The post-glacial gorge below the Falls was, of course much more difficult to cross and for many miles above the stream is considerably wider, averaging about 860 feet in width, nowhere less than 520, whereas here the wider arm is but 460 feet. Even that caused the first railroad to halt for five years on the eastern bank, passengers and freight using the highway bridge to cross; and later, when bridges could be more readily built both above and below the falls, the great majority of lines crossed the river within a few miles of this point.

But the special attraction of the Nicollet Island crossing was due in large part to its nearness to the flour mills at the Falls of St. Anthony (Fig. 4), half a mile below it, and perhaps in small part to the lumber mills just above it. These together formed the first industrial center of the district and for a long time dominated the trade not only in lumber and flour but also in grain. Subsequently, when mills and elevators were built along the railroads away from the falls, the location of Minneapolis nearer than St. Paul to the western farmers may have been of some minor advantage.

The comparison of these two centers might be summarized thus: St. Paul was situated at the head of main river navigation, at the junction of minor navigable branches, on the outside of a great bend, and at a site most convenient for gaining access to the river; Minneapolis-St. Anthony was situated at the most convenient river crossing and at the source of water power from the falls.

Had these two points been closer together, the rail lines might well have developed a single, though fairly complex, center; but the ten-mile separation was too great for that. On the other hand, the two were so close that each sooner or later received the full advantage of almost all the lines passing to the other. In some cases, this resulted from direct efforts of one city to secure an independent connection with a line terminating in the rival city. Thus the City of Minneapolis, as well as its business men, contributed to the capitalization of the Minneapolis and St. Louis Railroad. This originally consisted of two stub ends, one cutting northeast to connect with the line from St. Paul to Duluth, the other cutting southwest to connect with the line along the Minnesota Valley from St. Paul. In most cases, however, the desire of the individual railroads terminat-

ing at either center to increase their traffic caused them to secure their entry into the other by means of trackage rights over one of the established lines and to construct their own yards and freight terminals in both centers.

The situation gave the two centers about the same rail advantages in all the tributary area of the central northwest except the immediate vicinity. Consequently, the choice of location of new factories or warehouses depended, not on the connections with the region, since these were practically the same at both cities, but on local factors, such as switching arrangements, land, etc., or personal enterprise. During the period of rapid development from small towns to metropolitan centers, the two increased at a remarkably equal rate so that neither city attained any considerable advantage of size. Since 1900, Minneapolis has grown much more rapidly; but by that time St. Paul had attained its metropolitan maturity, so that the present greater size of the one has given it practically no degree of dominance over the other.

The Future Status

What of the future? Is there any likelihood of a change in the relationship of the cities? The railroad system, as has been said, was the main factor in the great growth of the urban district as one of two centers, and change in the rail structure would be difficult and costly. Physically it would be possible to create a new center of rail traffic, passenger and freight, in the Midway District, supplanting ultimately or immediately the present centers in whole or in part. If the distance were less and the cities smaller, this would be a practical possibility as well. Such a change is said to have been forced on the adjoining towns of Neenah and Menasha in Wisconsin. But the passenger station in this case would be about five miles from either of the present cores. Any changes in the rail system can no longer precede but can only accompany changes in the two nuclei of the cities. Will these ultimately coalesce?

It must always be remembered that, though the outlying sections of the cities now essentially overlap, their commercial cores are today almost as far apart as they were at the start; only phenomenal and totally unexpected growth could lead to coalescence. In any case the Minneapolis core is at present definitely growing in the opposite direction. The development of a new commercial core in or near the Midway District to displace, immediately or ultimately, both of the present ones meets similar objections to that regarding a new rail center. It would involve such enormous loss in invested property as to appear totally impracticable.

On the other hand the increasing disparity in size of the two cities, together with any possible increase in rapidity of communication

by subways or elevated lines, may tend to some extent to break down the present marked separation in the local business. At the same time present trends indicate that the zone of contact between the two cities will increase in length and in intensity, as industrial growth is greater there today than elsewhere in the urban area.

It is beginning to be recognized that there is an ever increasing need for coördination of various "functions of circulation": street cars, telephone, water supply, sewage disposal, police control, health supervision, and the like. The development of some sort of coördination in these various functions might conceivably lead to some sort of combined political organization—a possibility that has been discussed by various civic bodies since the early days of the two cities. But any such combination could not be organized as an ordinary unified city, for, as cities are controlled from their centers, each of the commercial cores will continue to give its identity to its respective member of the combination. A new form of political organization would be needed.

As far as can be seen, the geographical status is likely to be maintained. The railroad structure as a strong factor of inertia, and the two commercial cores with their vast fixed investment, strengthened by psychological factors, tend to make permanent this unique geographical form—a double center of separated cores.

THE FIRST EXPLORERS OF THE COLUMBIA AND SNAKE RIVERS

J. Neilson Barry

THE accompanying map, Figure 1, is a drawing on a reduced scale of a "lost" map of the lower Columbia River, Lieutenant Broughton's survey of 1792, discovered in London in 1929 by Admiral H. P. Douglas.[1] The survey is noteworthy both for its accuracy and for the controversy to which it gave rise and of which an echo still lingers in the argument as to whether the mouth of the Columbia is a river estuary or an inlet of the sea.

Discovery of the Columbia from the Sea

Although the vast circuit of the Columbia basin is thousands of miles in length, only some ten miles of it actually fronts on the Pacific coast. This tiny portion was first seen by a white man in historical record, in 1775, although previously some shipwrecked sailors had lived here. On August 17 of that year the Spaniard Bruno Heceta gazed at the long reach of the Columbia River that stretches back some thirty miles from the sea; but the raging waters on the bar, discolored by the churned-up sand, prevented his entrance. Heceta named the rugged promontory on the north Cape San Roque, and the low sandy point at the south of the entrance Cape Frondoso, while the long expanse of water he called the Bay of Assumption; and his chart (Fig. 2) shows that he saw Jim Crow Point and Cathlamet Head. In later times the Spaniards called this Heceta's Inlet and the river the San Roque.[2]

In 1788 the English navigator Captain John Meares also came and, after seeing the raging waters on the bar, turned away in disgust commemorated in the new name he gave Cape San Roque, Cape Disappointment, though his name Deception Bay has not "stuck." The recent construction of jetties reaching for miles into the ocean has caused the river to wash the bar entirely away, but in the early days the flood of water pouring down from the mountains[3] met the

[1] A photostat copy of the map has been presented to the American Geographical Society by Mr. Homer D. Angell, of Portland, Ore., president of the Trail Seeker's Council, an organization for the promotion of local historical research.

[2] An account of Heceta's voyage is printed in Robert Greenhow: Memoir, Historical and Political, on the Northwest Coast of North America, and the Adjacent Territories, *26th Congress, 1st Sess., Senate Doc. No. 174*, 1840; and also in *idem:* The History of Oregon and California, Boston, 1844, pp. 119–120 and 430–433.

[3] The mean discharge of the Columbia River is 276,000 second feet, greater than that of the St. Lawrence at Ogdensburg, N. Y.

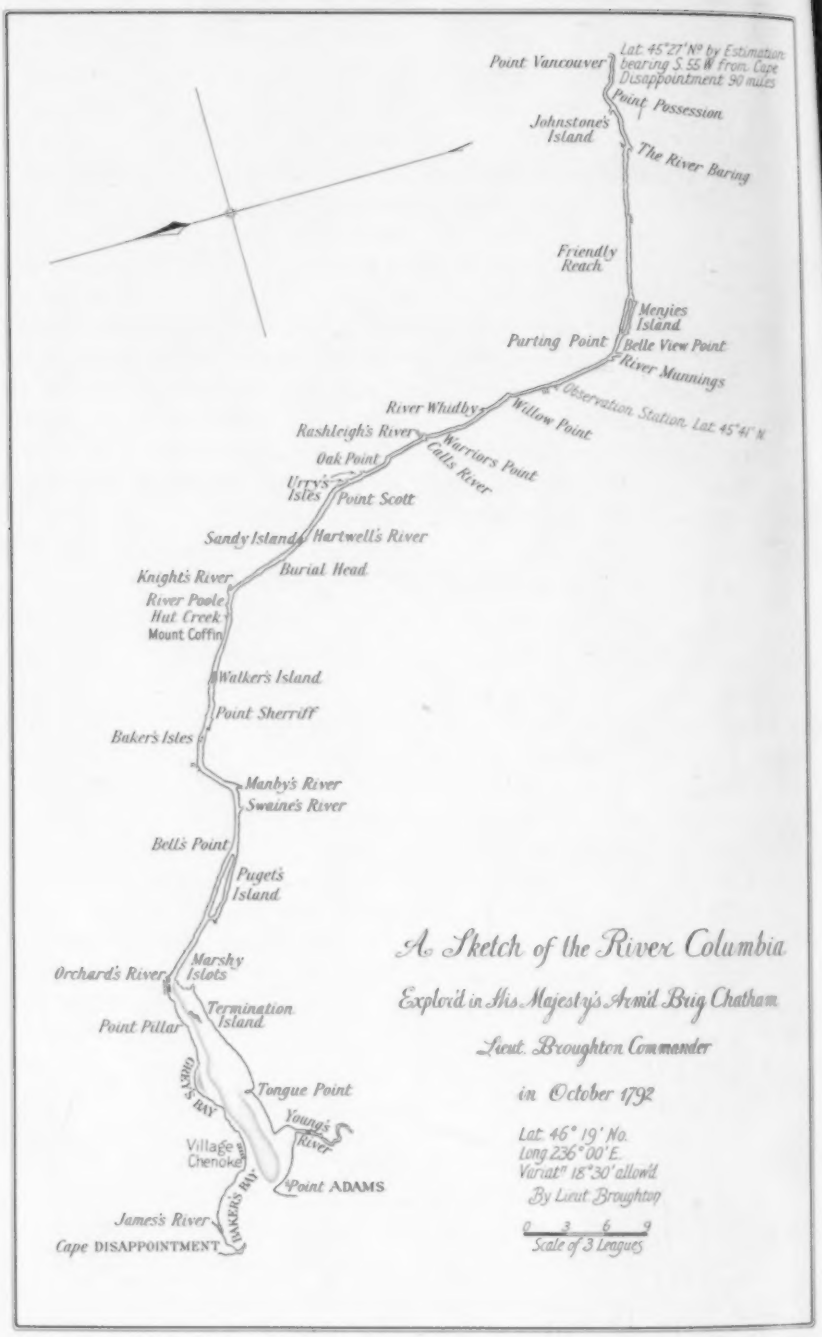

FIG. 1—Drawing on a greatly reduced scale of Lieutenant Broughton's map of the Columbia River (1792). Because of the reduction (more than one-fifth) the soundings are not shown, but all place names appear in the spelling of the original.

countercurrents and tides of the ocean and made of the water on the bar a dangerous place. Consequently when Captain Robert Gray arrived on his staunch little ship, the *Columbia Rediviva* of Boston, he too was compelled to turn away.[4] The next comers were Captain George Vancouver, on H. M. S. *Discovery*, and Lieutenant William

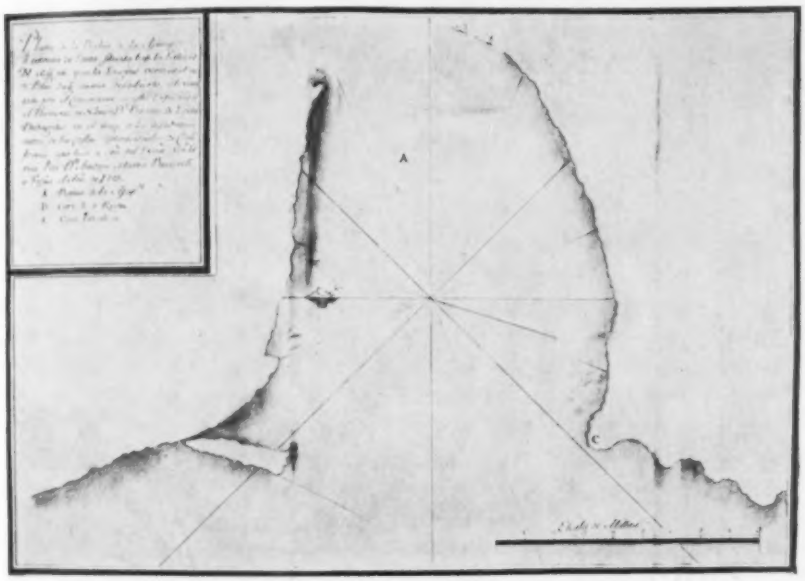

FIG. 2—Reproduction on a reduced scale of Heceta's map of the entrance to the Columbia River, 1775. A, Bay of Assumption; B, Cape San Roque (Disappointment); C, Cape Frondoso (Pt. Adams). The ship's position was latitude 46° 12′ 30″ N.; longitude 124° 10′ W.

Robert Broughton, on H. M. S. *Chatham*, who arrived in 1792 and noted how the river water discolored the ocean for miles.[5] Yet, after looking in on April 27, they too passed on. Wilkes's comment on the subject is worth quoting:

. . . I found breakers extending from Cape Disappointment to Point Adams, in one unbroken line.

I am at a loss to conceive how any doubt should ever have existed, that here was the mouth of the mighty river, whose existence was reported so long before the actual place of its discharge was known, or how the inquiring mind and talent

[4] Captain Gray's log of this voyage has been lost except for an extract which happily covers the period May 7 to 21. A complete account survives in the journal of John Boit, published by the Massachusetts Historical Society in Volume 53 of its *Proceedings* (Boston, 1920, pp. 217–275), the relative portion of which was reproduced with careful annotations in the *Washington Historical Quarterly*, Vol. 12, 1921, pp. 3–50. Reprints of the log of Captain Gray and of John Boit with notes by T. C. Elliott are in the *Oregon Historical Quarterly*, Portland, Ore., Vol. 22, 1921, pp. 308 and 352. *See also* E. G. Porter: The Discovery of the Columbia River, *Old South Leaflets No. 131*, Boston, Mass.

[5] George Vancouver: Voyage of Discovery to the North Pacific Ocean, etc. (2nd edit., 6 vols., London, 1801), Vol. 2, p. 34.

C. F. Newcombe, edit.: Menzies' Journal of Vancouver's Voyage (Archives of British Columbia, Memoir No. 5), Victoria, B. C., 1923.

Edmond S. Meany, edit.: A New Vancouver Journal, *Washington Hist. Quart.*, Vol. 5, 1914, pp. 129–137, 215–224, and 300–308; Vol. 6, 1915, pp. 50–68.

of observation of Vancouver could have allowed him to hesitate, when he must have seen the evidence of a powerful flood of fresh water contending with the tides of the ocean, in a bar turbulent with breakers, in turbid waters extending several miles beyond the line of the shore, and in the marked line of separation between the sea and river water . . .

Mere description can give little idea of the terrors of the bar of the Columbia: all who have seen it have spoken of the wildness of the scene, and the incessant roar of the waters, representing it as one of the most fearful sights that can possibly meet the eye of the sailor.[6]

Captain Robert Gray was not a man to give up trying. He returned on May 11, triumphantly crossed the dreaded bar, and floated the stars and stripes on the great river, which he renamed the Columbia and in so doing not only commemorated his ship but paid tribute to America and its great discoverer of 1492. He also gave the name Point Adams, which is still retained; but Cape Hancock did not replace Meares's "Cape Disappointment." He sailed up ten miles to Point Ellice and then six miles up the little bay that still bears his name and found the water so fresh that he was able to fill his casks from the side of his ship. The Indians were not only friendly but honest, and they gladly traded two salmon for a board nail, which may indicate the cost of the 150 sea-otter skins, the 300 beaver, and 600 land pelts that were purchased. For more than half a century the old name Oregon River was still in use; but now only Columbia, the dove of peace, is applied to this mighty river—all honor to the brave American skipper who first dared the crossing of the bar.

Captain Gray reported his achievement to the commandant of the Spanish fort at Nootka, on Vancouver Island, and gave him a sketch map with an anchor drawn to show where he had moored his vessel in Gray's Bay. Here Vancouver, learning of the feat, obtained a copy of the map and returned to the scene. From October 19 to 21, 1792, he again sought in vain to enter the river.[7] Broughton, however, succeeded in crossing the bar on October 20, and to him was left the exploration of the river. He spent three weeks making so good a survey that, as a steamboat captain recently asserted, a steamer could be brought up the river by it today. After surveying the entrance and discovering and exploring Young's River, he reached and named Gray's Bay where the anchor drawn on the sketch map showed that the *Columbia Rediviva* had been moored. At Jim Crow Point he climbed the hill for observation and saw the river behind some islands. The numerous details of each exploring party are of interest, but merely the bare outlines can here be given.

Broughton mentioned the peculiar battle-axes used by the Indians

[6] Charles Wilkes: Narrative of the United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, Philadelphia, 1845, Vol. 4, p. 293.

[7] Vancouver, *op. cit.*, Vol. 2. See under dates April 27, 1792; April 29–30; October 19–21. Also Vol. 3, p. 85.

in the vicinity of what is now St. Helens, Ore. More particulars of these unusual weapons are given in Bell's journal, with a sketch that shows them to be similar to the type characteristic of the Sioux and Chippeway.[8] This throws light upon the statement of the Indians that they had been obtained in barter from tribes to the east. On October 30, 1792, Broughton landed within sight of the entrance to

FIG. 3—Airplane view of Point Vancouver, named by Broughton, 1792. In the background the gorge of the Columbia, the Cascades, and Mt. Hood. In the middle distance Point Vancouver on left and Crown Point on right; Washougal slough and Cottonwood Point on left and Reed Island. Towards foreground Gary Island and remnant of Flag Island; Sandy River. Broughton's landing is now the center of the main channel between the nearer end of Reed Island and Cottonwood Point. (Copyright by Brubaker Aerial Surveys, Portland, Ore.)

the great gorge of the Columbia and took possession in the name of his king;[9] the remnant of the island on which he stood is now named Flag Island. He also named Mt. Hood and Point Vancouver. A friendly old Indian chief showed to him by signs that the rapids at the Cascades were a short distance beyond the entrance to the gorge—pouring water from his hands and making the sound of the river rushing over the rocks. No original report of his discovery by Broughton is known to exist, though search has been made.[10] We have Vancouver's report, and the writer has in his possess on a copy of a heretofore unpublished manuscript journal of the exploration. written presumably by Edward Bell, clerk of the *Chatham*.[11]

THE COLUMBIA AN ANCIENT HIGHWAY

Thus far was the Columbia explored from the sea. The larger part of the basin, occupying an area of 262,300 square miles, became

[8] J. Neilson Barry: Spaniards in Early Oregon, *Washington Hist. Quart.*, Vol. 23, 1932, pp. 25–34; see especially footnote 7, p. 26.

[9] J. Neilson Barry: Broughton, Up Columbia River, 1792, *Oregon Hist. Quart.*, Vol. 32, 1931, pp. 301–312.

[10] See *Geogr. Journ.*, Vol. 45, 1915, pp. 250–251.

[11] The original is in the Turnbull Library of Wellington, New Zealand. The writer is publishing the portion relative to the Columbia in "Columbia River Exploration, 1792," *Oregon Hist. Quart.*, Vol. 33, 1932, pp. 31–42 (the second instalment will appear in the June number).

known from overland expeditions, piecemeal, during a period of forty-four years. Table I (pp. 454–455) is a compilation classifying the more important items. Since each expedition gave names that usually differ from the modern ones and the various spellings often obscure well known names, no attempt is made to designate the various names for each tributary but merely to give the summary of each itinerary by modern names. The river itself has been called the Oregon,[12] the Great River of the West, the San Roque, the Chinook, and the Columbia.

The gorge of the Columbia forms a natural gateway that has been a highway from time immemorial. Just before reaching the gorge the river plunges over the Celilo Falls and then into a chasm. This obstruction was peculiarly adapted for salmon spearing at the time when the region had a large Indian population. Great multitudes would gather there; and the opportunity for barter was seized, tribes from the Rocky Mountains bringing such things as material for baskets and seines in exchange for articles from the seacoast.

Since the original population of America seems to have spread southward along the Pacific coast[13] the settlement at The Dalles must have been made at a very early date and indeed may be the most ancient Indian village now existing on the continent. Washington Irving in his "Astoria" gives a graphic account of the village of Wishram. It may be seen in the illustration, Figure 4.

This ability to obtain desired commodities by barter instead of rapine, by developing the trading instinct rather than war, promoted an amicable relationship among the tribes. In consequence the Indians were able to travel extensively; and early travelers not only found them friendly and hospitable but also discovered in practically every tribe both men and women who were familiar with a large section of the country and able to depict it by maps. Mr. Fred S. Perrine of Oregon City recently obtained relics from the site of an Indian village that he had located by a map drawn by an Indian for the Lewis and Clark expedition.

That the aboriginal commerce extended over great distances was shown in 1793 when Alexander Mackenzie found Indians east of the Rocky Mountains with articles of iron obtained by them from a tribe living eleven days' journey distant. These Indians had traveled a whole month to barter with a tribe that had obtained the articles from Indians living on the seacoast where white men had come in ships "as big as islands." This was in the region directly north of the Columbia basin.[14] Mackenzie assumed that the Fraser

[12] Barry, Spaniards in Early Oregon.

[13] Aleš Hrdlička: The Origin and Antiquity of the American Indian, *Ann. Rept. Smithsonian Instn. for 1923*, pp. 481–494.

[14] Sir Alexander Mackenzie: Voyages from Montreal Through the Continent of North America (2 vols., reprint, New York, 1922), Vol. 2, pp. 91 and 327. First published in 1801.

FIG. 4

FIG. 5

FIG. 4—Wishram Indian village at The Dalles. View from the Oregon side of the river.
FIG. 5—Airplane view of the Columbia River between the Snake River and Celilo Falls. (Copyright by Brubaker Aerial Surveys, Portland, Ore.)

River was the upper part of the Columbia and so showed the connection on his map by a dotted line and the name "Tacoutche Tesse or Columbia river," which subsequently caused Lewis and Clark to suppose that Clark's Fork (Montana) was a branch of the Ca-coutche Tesse and in 1811 caused a letter carrier from Spokane House to the Fraser River to travel fifteen hundred miles out of her way.[15]

The Indians of the plains also traveled long distances, but the idea of trade seems not to have been so prominent as rapine. While Lewis and Clark were at the Hidatsu villages of North Dakota they interviewed (March 8, 1805) Indians who had just returned from the Rocky Mountains.[16] The famous Sacajawea, who accompanied her husband with that expedition, had been captured by the Hidatsus from her Shoshone tribe which lived around Lemhi Pass, Idaho. Clark while with those Shoshones met an Indian who had just arrived from within horse-stealing distance of the Spaniards in California, while the large number of Spanish animals and articles with Sacajawea's people demonstrated the extent of the long-distance commerce, since they had bartered them from the original purloiners. The Shoshones ranged as far as The Dalles, where the Deschutes River was called for them the To-wor-ne-hi-ooks. This explains how a pipe bowl of Sioux manufacture was recently found in an Indian grave near Portland and why the first explorers on the Columbia, as has already been noted, found the Indians with a peculiar style of battle-axe characteristic of the Sioux and Chippeway Indians, which they said had been bartered from tribes toward the eastward. It is not impossible, then, that some knowledge of the Great River of the West may have reached the most western supply post during the French régime in Canada. Knowledge of the river undoubtedly existed at Fort Mackinac in 1760 and so introduces our first knowledge of it.

First Knowledge of the Columbia

It seems a far call from Oregon to the massacre of Fort William Henry, yet two of the survivors of that massacre, who later aided in the capture of Montreal, figure prominently in the story. One was Major Robert Rogers of the noted Rogers Rangers who was sent in 1760 to take over the French post at Mackinac. While there he seems to have learned of the Oregon River, for he went to England and in 1765 petitioned the king to be allowed to lead an expedition to the Pacific Ocean by way of the Oregon River, which is frequently

[15] The writer has an article in the *Washington Historical Quarterly*, Vol. 20, 1929, pp. 201–203 (see also Vol. 21, 1930, pp. 120–130) in regard to the Kootenay woman who carried the famous letter.

[16] Of the many accounts of the Lewis and Clark expedition, the most complete is R. G. Thwaites: The Original Journals of the Lewis and Clark Expedition, Dodd, Mead & Co., 1904–1905. This does not include the Journal of Patrick Gass. J. K. Hosmer: History of the Expedition of Lewis and Clark, McClurg, 1902, is a careful reprint of the Biddle edition. O. D. Wheeler: The Trail of Lewis and Clark, Putnam, 1904, is very valuable.

mentioned in his written records with much variety of spelling. In 1766 he was placed in command of Fort Mackinac and actually did send an expedition under Captain James Tute, while Captain Jonathan Carver who had also been at Fort William Henry and Montreal was commissioned as the draftsman. The expedition was a failure, yet Rogers was so convinced of a practical route to the Pacific via the Oregon River that he again went to London and presented another petition in 1772. This seems to have been the original provocative of Thomas Jefferson's determination that Americans should be the first to reach that river.[17] Captain Carver also went to London and in 1778 published a book in which the Great River of the West and the Oregon were first mentioned in print. Parenthetically it may be remarked that the source of Rogers' seemingly definite information is a problem of very great interest.

Fur traders from Canada in early days had extended their explorations to the Rocky Mountains; but the first men known to cross to the Columbia basin were Charles La Gasse and a certain Le Blanc who in 1800 accompanied some Kootenay Indians to spend the winter with that friendly tribe. Unfortunately, there is no further record; although La Gasse was often mentioned in later years. There are a number of allusions to other trappers having crossed the Great Divide, but no details.[18]

The Lewis and Clark Expedition

The efforts by Major Rogers had caused President Jefferson to make several attempts at an overland expedition, one of which finally resulted in the dispatch of Lewis and Clark, who in August, 1805, crossed Lemhi Pass (Lemhi, Ida.), followed it to Salmon River, and then across the Bitterroot Range to the Bitterroot River (Montana) and down to "Travelers' Rest" (Lolo Creek near Missoula, Mont.). They then crossed Lolo Pass and reached the Clearwater (Weippe, Ida.) and, having made boats (Oro Fino, Ida.), reached the Snake River and in October, 1805, descended the Columbia to Cape Disappointment. They built Fort Clatsop on Lewis and Clark River, near Astoria, Ore., and in the spring began their long return journey. At The Dalles they obtained horses and returned via Lolo Pass to Travelers' Rest Creek. Clark then returned up the Bitterroot River and crossed the Rockies (Gibbon Pass) while Lewis went up Clark's Fork, the Blackfoot River, and Lander's Creek to the Lewis and Clark Pass.

[17] Documents relating to Rogers and Carver with valuable notes by T. C. Elliott are printed in the Oregon *Historical Quarterly*, Vol. 21, 1920, pp. 341–368; Vol. 22, 1921, pp. 91–115; Vol. 23, 1922, pp. 53–69.

[18] Elliott Coues, edit., New Light on the Early History of the Greater Northwest: The Manuscript Journals of Alexander Henry and of David Thompson, 1799–1814 (3 vols., New York, 1897), Vol. 2, pp. 652, 661, 668, and 704.

David Thompson's Explorations

The North-West Company was a rival of the Hudson's Bay Company, and both had extended their posts to the Rockies; but the North-West had a great advantage in having as partner a really

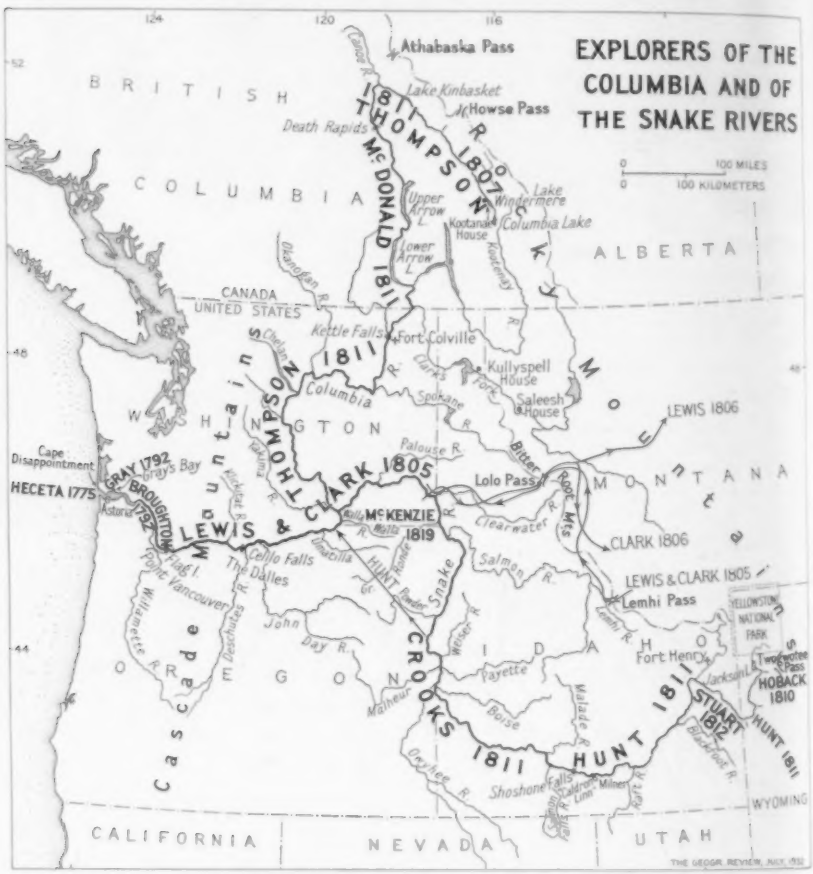

FIG. 6—The Columbia and Snake rivers showing the progress of exploration. Scale approximately 1 : 11,500,000.

extraordinary geographer, David Thompson.[19] His energy is hardly believable; he traveled almost continuously and made accurate surveys of a vast area. The Indians called him the "Star Man" because of his carrying a telescope and observing the stars. In 1806 he sent Jacques Raphael Finley across Howse Pass to the Columbia River at Blaeberry Creek to prepare the material for boats and the

[19] For David Thompson see J. G. Tyrrell, edit.: David Thompson's Narrative of His Explorations in Western America 1784–1812 (Champlain Society Publs., No. 12), Toronto, 1916; articles by T. C. Elliott in the *Oregon Hist. Quart.*, Vol. 15, 1914, pp. 39–63, 104–125, 216, and 241–251; Vol. 21, 1920, pp. 49–61; Vol. 26, 1925, pp. 23–49 and 191–202; Vol. 27, 1926, pp. 279–291. Several of Thompson's original journals have been published with annotations in the *Washington Historical Quarterly*.

following year (1807) followed him and ascended the Columbia River to its source in Columbia Lake. He established the trading post of Kootanae House, near Lake Windermere, B. C., in 1807. Shortly afterwards a party of forty-two Americans crossed the Rockies, among whom were two members of the Lewis and Clark expedition, and a Lieutenant Jeremy Pinch, who had a most curious and interesting correspondence with Thompson.[20] It seems possible that the American trading post was near Dixon, Mont., and was seen by Alexander Ross in 1824[21] but was erroneously supposed to have been the one erected by Mr. Howse of the Hudson's Bay Company in 1810, which was on Flathead Lake. Another American, Nathaniel Winship, started in 1810 to build a post on the lower Columbia (near Mayger, Ore.), and Andrew Henry in 1810 erected Henry's Fort (St. Anthony, Ida.) on the branch of the Snake River that still bears his name. With him were three free trappers, John Hoback, Edward Robinson, and Jacob Reizer, of whose experiences Washington Irving has given a graphic account in his "Astoria." These are the first known to have explored the Snake River between Hoback and Buffalo rivers, Wyoming, and they appear to have returned via Blackrock Creek and Twog-wo-tee Pass. Before reaching St. Louis they fell in with the Astoria Overland expedition and turned back to act as guides for them.

David Thompson was the first (1811) to explore the Columbia from Canoe River to Blaeberry Creek. He continued on to Columbia Lake, where the river has its highest source, and via Spokane House to Kettle Falls on the Columbia. He then explored and surveyed the river downstream, reaching at the Yakima the part of the river already explored by the Lewis and Clark expedition. He continued his survey to the Pacific and visited the newly established American fort at Astoria. He returned up the river to Spokane House via the Snake River and then back to the Columbia at Kettle Falls, where he wrote a letter and gave it to the Indians to pass from tribe to tribe in a way that subsequently became customary. This letter was received 232 days later at Fort St. James on Stuart Lake (British Columbia).[22]

Meanwhile Thompson had sent Finan McDonald to explore up the Columbia from Kettle Falls, and he had ascended to Death Rapids. Thompson retraced McDonald's route and explored the last stretch of river to Canoe Encampment, so that in that year he had navigated the entire Columbia between its source and the ocean.

[20] Professor R. C. Clark, of the University of Oregon, discovered a remarkable correspondence between Lieutenant Pinch and Thompson carried on in 1807. This is printed in Professor Clark's History of the Willamette Valley, p. 839 (see also p. 122). Thompson's reference to the forty-two Americans is in his journal for August 13, 1807, see *Oregon Hist. Quart.*, Vol. 26, 1925, p. 42.

[21] Alexander Ross: The Fur Hunters of the Far West (2 vols., London, 1855), Vol. 2, p. 8.

[22] Daniel W. Harmon: A Journal of Voyages and Travels in the Interior of North America, etc. (reprint, New York, 1922), p. 184. First published in 1820.

THE EXPLORATION OF THE COLUMBIA RIVER

EXPLORERS	RIGHT SIDE	CENTER	LEFT SIDE
THOMPSON *Up*, 1807 111 *miles*		Columbia Lake Lake Windermere	Kootanae House, N. W. Co., 1807
	Blaeberry Creek (Howse Pass)		
THOMPSON *Up*, 1811 82 *miles*		Lake Kinbasket	
	Canoe R. (Athabaska Pass)		
THOMPSON *Up*, 1811 52 *miles*			
		Death Rapids Upper Arrow Lake Lower Arrow Lake	
MCDONALD *Up*, 1811 255 *miles*			Kootenay R. (McGillivray R.) (1) Kootenay post, N. W. Co., 1808 (2) Astor post, 1812 Clark's Fork (Lewis and Clark, 1805 and 1806) (1) Post of Pinch, 1807 (2) Koaster post, 1809 (3) Kullyspell House, N.W. Co., 1809 (4) Saleesh House, N. W. Co., 1810 (5) H. B. Co. post, 1810 (6) Astor post, 1812
	Boundary between	British Columbia	and Washington Fort Colville, H. B. Co., 1825
	Kettle R.		
		Kettle Falls	(Ilth-ko-yape Falls) Colville R. Spokane R. Spokane House, N. W. Co., 1810 Astor post, 1812
THOMPSON *Down*, 1811 366 *miles*	Sanpoil R. Nespelim R. Okanogan R. Astor post, 1811 Methow (Barrier) R. Chelan R. Entiat R. Wenatchee (Pisquouse) R. Yakima R. (Tapteal, L-C)		
			Snake R. (Lewis, Sha-hap-tin) Fort Nez Percé, N. W. Co., 1818 Walla Walla R.
			Boundary between Washington and Oregon
LEWIS *and* CLARK *Down*, 1805 212 *miles*		Umatilla Rapids	(Muscleshell, L-C) Umatilla R. John Day R. (Lepage, L-C) Deschutes R. (To-wor-ne-hi-ooks, L-C)
		Celilo Falls	
	Wishram village		
		The Dalles	(Long Narrows, L-C) Mill Creek (Quesnet, L-C)
	Klickitat R. (Canoe, L-C)		
		Memaloose I. Submerged forest	(Sepulchre I., L-C)
	White Salmon R. (Canoe, L-C)	Great Gorge	Hood R. (La Biche's, L-C)
	Wind R. (Crusatte's, L-C)		
		Cascades	
	Beacon Rock, Tidewater		
		Phoca Rock	(L-C)
	Point Vancouver (B)		
		Flag I.	Broughton landed, 1792
	Washougal R. (Seal, L-C)		
			Sandy R. (Quicksand, L-C)

L-C, names given by Lewis and Clark; B, names given by Broughton; N.W. Co., posts of North-West Co.; H. B. Co., posts of Hudson's Bay Co.

Explorers	Right Side	Center	Left Side
Broughton	(Johnstone's, B)	Lady I.	
Up, 1792		Government I.	
114 miles	Fort Vancouver, 1825	Friendly Reach (B)	(Diamond, L-C)
		Tomahawk I. (L-C)	
	(Menzie's, B)	Hayden I.	(Image Canoe, L-C)
	Matthew Pt. (Parting, B)		Belle Vue Point, B
			Willamette R. (Mannings', B; Multnomah, L-C)
		Sauvies I.	(Wappato, L-C)
	Lewis R. (Rushleigh, B)		Point Warrior, B
			Multnomah Channel (Call's, B)
	Oak Point, H		
	Kalama R.		
			Coffin Rock (Burial Head, B)
	Cowlitz R. (Knight's, B)		
	Mount Coffin (B)		
	Oak Point (modern name)		Oak Point, Astor post, 1812
			Clatskanie R. (B)
		Puget I.	
	Skamokawa R. (Orchard's, B)		Broughton considered this the mouth of the river
	This wider portion was called	Assumption Bay, 17	75, Deception Bay, 1788, and
		Heceta Inlet	
	Jim Crow Point		
		Pillar Rock	
	Harrington Point		
		Cathlamet Bay	
	Gray's River	Gray's Bay (B)	
	Deep R.		John Day R.
Gray, 1792			Tongue Point (Pt. William L-C)
19 miles	Point Ellice		Astoria, 1811 (Ft. George 1813)
			Smith Pt. (Point George, B)
		Young's Bay	Young's R. (B)
			Lewis and Clark R.
			Fort Clatsop, 1805
	Chinook R.	Baker Bay (B)	Point Adams (Gray, 1792)
	Wallacut R.		(Cape Frondoso, Heceta, 1775)
	Cape Disappointment		
Heceta, 1775	(C. San Roque, Heceta, 1775)		
	(C. Hancock, Gray, 1792)		
		Pacific Ocean	

The Exploration of the Snake River

Explorers	Right Side	River	Left Side
		Source	Teton County, Wyoming
?		Jackson Lake	
			Buffalo R., Blackrock Cr., Twog-wo-tee Pass
Hoback, Robinson, *and* Reizner, 1810			Gross Ventre R.
			Hoback R.
Hunt (Astor) 1811	(Teton Pass)	Grand Canyon	
?	Boundary Wyoming and Idaho		
Stuart (Astor) 1812		Lower Canyon	
Hunt (Astor) 1811	Henry Fork		
	(A. Henry, Fort, 1810)		Blackfoot R.
			Fort Hall, Oregon Trail
		"Caldron Linn,"	Milner, Idaho
		Shoshone Falls	
Crooks (Astor) 1811	Boise R., Reed Fort (Astor) 1813		Boundary Idaho and Oregon
			Owyhee R. (Sandwich Island)
			Malheur R. (Little Wyer)
	Payette R.		
	Weiser R.		
			Burnt R. Oregon Trail
			Powder R. (Port-pel-la)
?		Canyon	
McKenzie, N. W. Co. 1819	Salmon R. (Lemhi Fork, L-C, 1805)		
	Clearwater R. (Kooskooske, L-C)		
Lewis *and* Clark, 1805			Ore.-Wash. Boundary
	Idaho-Wash. Boundary		Grand Ronde R.
	Palouse R. (Drewyer, L-C)		Tucannon R. (Kimooenim Cr., L-C)
		Columbia River	

The Astoria Expedition

The overland expedition to Astoria under Wilson Price Hunt[23] was guided by Hoback and his companions until near Twog-wo-tee Pass. Here they decided to obtain buffalo meat and crossed Union Pass to the basin of Green River, Wyoming, and then traveled down Hoback River to the Snake which they explored to the Grand Canyon. Via the Teton River they came to the deserted Fort Henry (St. Anthony, Ida.). Here they unfortunately left their horses and made boats in which they descended Henry Fork and the Snake River to "Caldron Linn" (Milner, Ida.), beyond which the river is not navigable. Divided into several parties they pushed on afoot. Ramsey Crooks followed the left bank as far as the great canyon of the Snake (Homestead, Ore.), whence he was forced to turn back. Hunt was guided by an Indian over the old Indian route that became the Oregon Trail (between Huntington, Ore., and Umatilla, Ore.). The third party under McKenzie managed to find the Indian route through that rugged region between Weiser, Ida., and Lewiston, Ida., which is called the Seven Devils.[24]

The experiences of Donald McKenzie in passing through the Seven Devils region made him wish to ascertain whether the great canyon of the Snake River could be navigated. In 1819, when a partner of the North-West Company, he actually did ascend from the Clearwater to a point that he called "Point Successful, Head of the Narrows." Whether this was on Salmon River or even near Homestead, Ore., cannot be ascertained.[25] In more recent times venturesome men have gone down that terrible canyon in boats, and a steamboat has actually navigated it. At some future time the water power now going to waste may be made available and dams may create a navigable highway; but at present the frightful gorge remains as a challenge to such fearless spirits as those heroic men who first explored the Columbia and its tributaries.

[23] The author has given the itinerary in *Oregon Hist. Quart.*, Vol. 12, 1911, pp. 164–170; Vol. 13 1912, pp. 227–239.

[24] Ross Cox: Adventures on the Columbia River (2 vols., London, 1831), Vol. 1, pp. 89–92.

[25] McKenzie's account of his exploration of Snake River canyon is found in Ross, *op. cit.*, Vol. 1, p. 205.

PRECIPITATION MAPS OF NEBRASKA

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COMPETITIVE pressure upon agricultural production has increased greatly in recent years, and this has focused attention upon the marginal areas—the areas, that is, between humid and arid. In such areas the rainfall average is close to the minimum requirement for crop production, and the annual variation, typical of the midcontinent type of climate, is high. This results in the frequent occurrence of seasons or years wherein the rainfall is so light that crop failures result. On a world basis this line marks the general transition zone, usually designated by the 20-inch annual isohyet, from the semiarid to the humid types of natural and cultivated vegetation. Agriculturists have been rapidly increasing the areal utilization of the marginal lands by irrigation and by dry-farming methods. In the case of irrigation experience has taught the imperative need of precipitation studies, even those based upon scanty data. Experience has furthermore demonstrated that, in many cases where both are possible, dry-farming methods are more practical than irrigation. Where selection between these adaptations must be made, detailed rainfall distribution data are essential.

This is the situation in Nebraska. The annual isohyet of 20 inches passes approximately through the center of the state. In the eastern part of the state methods of agricultural procedure adapted to humid conditions prevail. On the uplands of western Nebraska vast tracts of land are tilled by dry-farming methods. In the central part of the state every gradation between the two is found. In this portion exists considerable maladjustment, some of which might be remedied by practical application of increased knowledge of rainfall distribution.

Climatographers have been reticent in drawing conclusions in areas such as this because of scarcity of climatic data, a scarcity due to the short period of time since permanent settlement has become widespread. But the fact that they are marginal zones challenges us to present the picture as it now appears in spite of its imperfections.

Construction of the Maps

The publications on Nebraska rainfall, aside from the routine reports of the Weather Bureau, are limited. To the writer's knowledge only one precipitation map has received widespread circulation

in the past, G. A. Loveland's "Average Annual Precipitation for the Different Sections of Nebraska."[1] The Weather Bureau's "Normal Temperature and Precipitation Map" of Nebraska (1930–1931), produced independently but subsequent to the annual map of this series (Fig. 1) coincides closely with it.

The maps herewith presented with their accompanying explanations treat three major phases of the distribution of rainfall—the general annual distribution, the monthly and seasonal distribution, and the distribution of the annual maxima and minima.

The basic data[2] were obtained by averaging the records for each listed observation station from 1921 to 1929 inclusive with the respective averages to and including 1920 as published by the United States Weather Bureau.[3] The final averages were plotted at their respective stations and the isohyets drawn on the original maps which were 23 x 45 inches in size.

In some cases difficulties arose. A record of 35 or more years was regarded as normal. Between stations with such records isohyets were located by suitable but strict interpolation regardless of any resulting apparent inconsistencies. Adherence to this plan is responsible, in part at least, for most of the unusually steep gradients. Defense of the method lies in the contention that actualities are thereby more faithfully, though not more beautifully, presented than by curves made too smooth by the omission of nonconforming data.

Records can be too short to be of value in such case, and obviously inconsistent averages obtained from records of less than 15 years' duration were largely disregarded. However, it was necessary to resort to this less than ten times in the entire series of nineteen maps.

Where great differences in data from contiguous stations appeared special adjustments were made. In all but four or five cases inconsistency was due to the fact that the station of shorter record had not included several very wet or very dry periods: contemporaneous records were consistent. The station of longer record was used as the criterion in placing the isohyets.

In the few cases where this did not apply the common proportional formula $a/b = A/B$ was used in making the adjustment. In this formula a and b equal the respective averages at the stations, A the full time recorded average at the station of longer record, and B the hypothetical average at the other station had the record been kept as long. The hypothetical average was then used in the location of the isohyets.

[1] The Climate of Nebraska, *Univ. of Nebraska Agric. College Extension Service, U. S. Dept. of Agric. Coöperating, Extension Circular 14*, April, 1923, p. 11.

[2] Grateful recognition is made to Doctor Nels A. Bengtson, Chairman of the Department of Geography of the University of Nebraska, and to Professor Thomas W. Blair, Chief of the Weather Bureau in Nebraska, for furnishing data and helpful suggestions in its treatment.

[3] *U. S. Weather Bur. Bull. W*, 2nd edit., 1926, Vol. 2, sections 35–37.

New Features Appearing on the Maps

The detail of the maps makes it possible to arrive at certain new conclusions and inferences. It has been assumed that the gradation of rainfall from east to west is broadly uniform. The position of the median isohyet on each map of the series is well to the east of the center of the state. Without question there is an accelerated rate

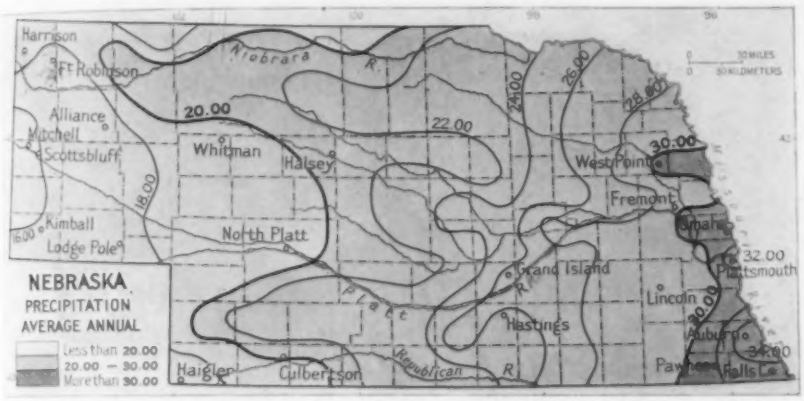


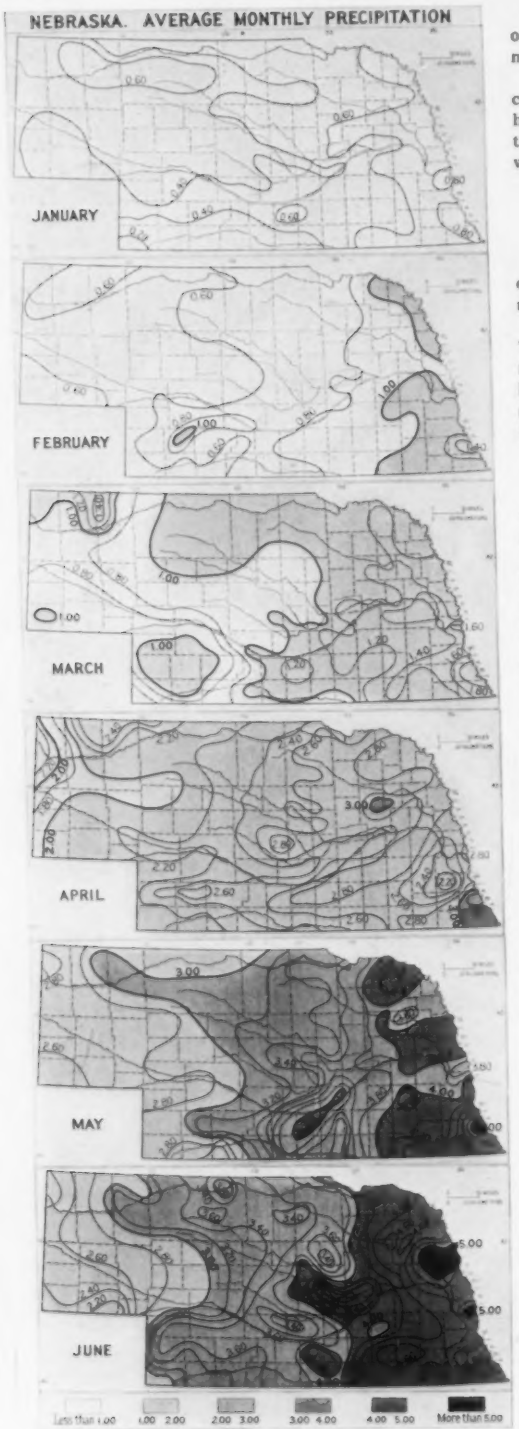
FIG. 1—Nebraska, mean annual precipitation in inches: isohyetal interval 2 inches. Range 18.87 inches, from 16.05 at Scottsbluff to 34.92 at Auburn; hypothetical median isohyet 25.00.

of increase in average precipitation from west to east. That this acceleration is more marked in the summer growing season than in winter is agriculturally significant.

The northeastern section is the state's chief corn-producing area, and corn is the money crop most subject to devastation by drought and hot winds. The supremacy of this section has been attributed rather vaguely to topography. The maps suggest that it may be due to the summer northward migration of the maximum of rainfall. The maximum for most of the year appears at Auburn, about 50 miles northwest of the point previously supposed to mark the maximum. The minimum for the year appears near the western border of the panhandle area well to the north of the extreme southwestern corner and shows a roughly similar migrational tendency, not, however, sufficiently substantiated by ample data nor clearly enough defined to warrant inferences as to any effect upon agriculture.

It has commonly been believed that, without exception, June is the rainiest month throughout the state. The maps show slightly more rain in May than in June in the panhandle area. That an early maximum favors wheat production and hinders corn production in the dry-farming areas is well known, an influence overlooked in laying the responsibility on light rainfall as the major limiting factor in corn production in western Nebraska.

The semblance of a pattern showing westerly looping of the iso-



January. Range 0.67 inches, from 0.18 at Haigler to 0.85 at Auburn; median isohyet 0.40.

January is the driest month on account of the effect of the continental high pressure at its maximum. Note the east-west trend of the isohyets with their long loops.

February. Range 1.09 inches, from 0.31 at Haigler to 1.40 at Auburn; median isohyet 0.80.

February is the third driest month. The isohyetal trend is more nearly north-south than in January. The loops are not as pronounced except south of the Platte and north of the Niobrara.

March. Range 1.22 inches, from 0.70 at Haigler to 1.92 at Auburn; median isohyet 1.20.

March, while dominantly dry, marks the inauguration of the transition from the dry to the wet season. The west loops south of the Platte persist. The wet area in the northwest has culminated in the peak at Hay Springs.

April. Range 1.48 inches, from 1.73 at Fort Robinson to 3.21 at Auburn; median isohyet 2.60.

April represents the peak of the transition season. The steep gradient from Fort Robinson west is based upon adjustment of a fifteen-year record at Harrison and is open to question.

May. Range 2.55 inches, from 2.52 at Kimball to 5.07 at Auburn; median isohyet 3.60.

May is the month of second greatest precipitation. Note the major north-south isohyetal trends modified in the two northern corners. The westerly looping in the southwest and northwest persists.

June. Range 3.11 inches, from 2.12 at Lodge Pole to 5.23 at West Point; median isohyet 3.80.

June is the month of greatest precipitation. The isohyetal trends are definitely north-south. Note the increased precipitation on the interfluvial area in the southwestern section and the northward migration of the maximum and minimum points.

FIG. 2—(Isohyetal interval 0.2 inch.)

July. Range 2.86 inches, from 1.95 at Mitchell to 4.81 at Plattsmouth; median isohyet 3.40.

July is a rainier month than has been generally supposed. Observe the continued major north-south isohyetal trend, the northward location of the maximum and minimum, and the westward loops south of the Platte. The driest area is in the Panhandle.

August. Range 2.69 inches, from 1.46 at Scottsbluff to 4.15 at West Point; median isohyet 2.80.

August is rainier than has been commonly supposed. See the major northeast-southwest isohyetal trends and the persistence of the loops between the Platte and the Republican.

September. Range 3.33 inches, from 0.83 at Whitman to 4.16 at Falls City; median isohyet 2.60.

The minimum at Whitman (17-year record) is open to question: a long time record would probably place it at Kimball. Note the southward migration of the maximum and the northeast-southwest trend of the isohyets.

October. Range 2.18 inches, from 0.64 at Whitman to 2.82 at Auburn; median isohyet 1.80.

Again the range and the location of the minimum are based upon the short record at Whitman. The isohyets in general have flattened. The maximum has returned to Auburn. Note the Platte-Republican area.

November. Range 1.26 inches, from 0.35 at Whitman to 1.61 at Pawnee City; median isohyet 1.00.

Lodgepole's 38-year record averaging 0.40 probably deserves the minimum. Observe the recurrence of the east-west isohyetal trend in the west as opposed to the continued north-south trend in the east.

December. Range 0.71 inches, from 0.40 at Haigler to 2.82 at Auburn; median isohyet 0.70.

December, the second driest month, in many respects duplicates January. Isohyets trend more nearly east-west, and the maximum and minimum have returned to the respective southeast and southwest corners.

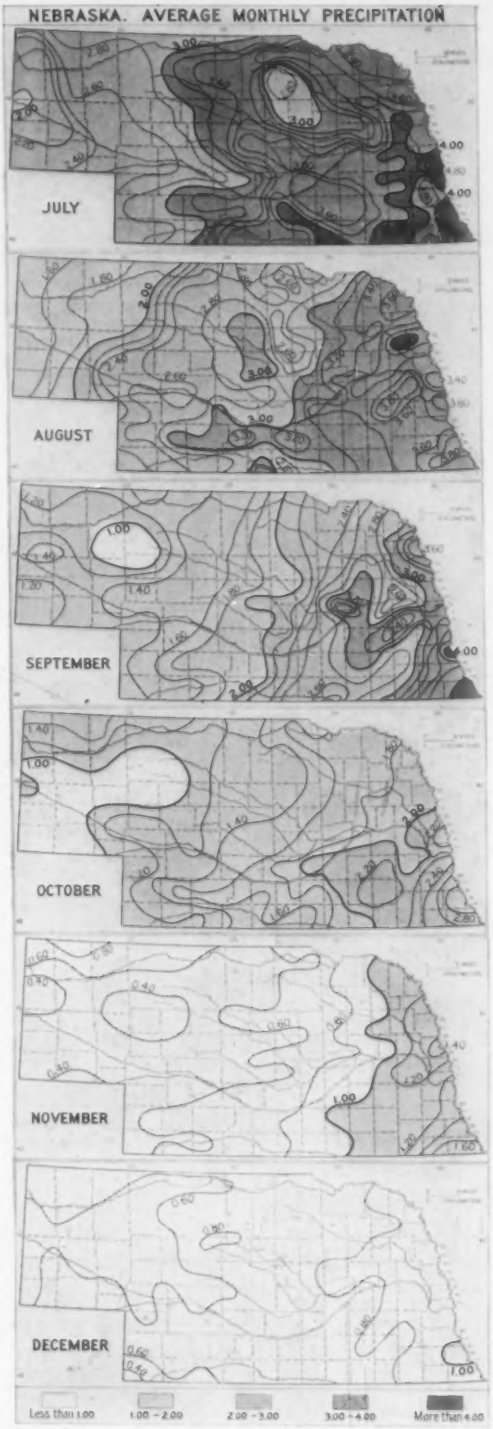


FIG. 2.—(For locations see Fig. 1.)

hyets in the northeast-central part of the state on most of the maps attracts attention. The same general arrangement is even more pronounced on the high tablelands in the northwest. This suggests

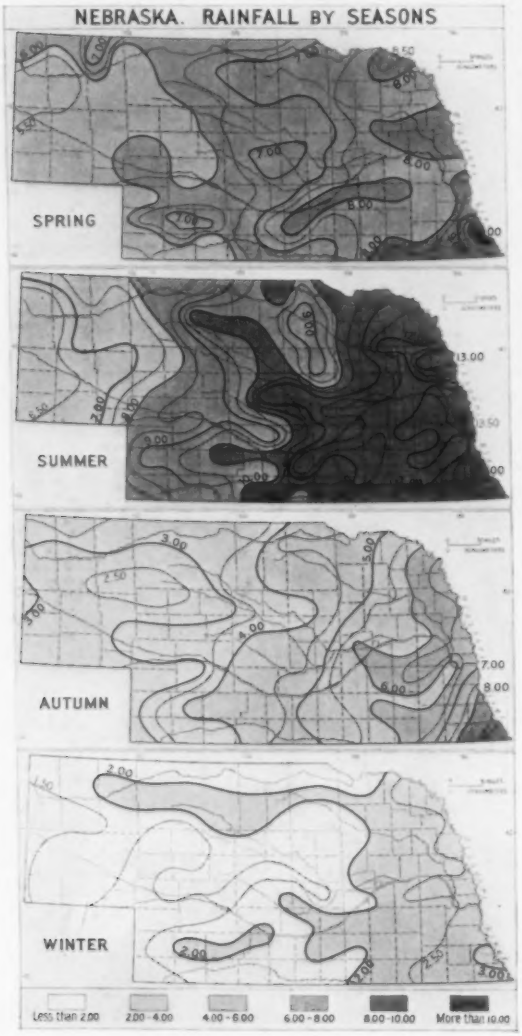


FIG. 3—Nebraska, precipitation by seasons.

Spring is a summary of March, April, and May conditions: range 4.78 inches, from 5.42 at Haigler to 10.20 at Auburn; median isohyet 7.50. Observe the steep gradients in the four corners of the state and the high in the south-central area. The precipitation between the Platte and the Republican is pronounced.

Summer, the rainy season: range 7.69 inches, from 6.10 at Scottsbluff to 13.79 at Plattsmouth; median isohyet 10.11. The general fan-shaped pattern of the isohyetal trends is plain. The westward loops tend to cover the longer east-west interfluvial areas, markedly so on the loess plain. Note the northward migration of the maximum and minimum.

Autumn: range 6.06 inches, from 2.45 at Alliance to 8.55 at Falls City; median isohyet 5.50. Note the tendency of the isohyets in the northwestern part of the state to flatten out, approximating winter conditions. The maximum point has returned southward to Falls City while the minimum remains at Alliance, near its summer position.

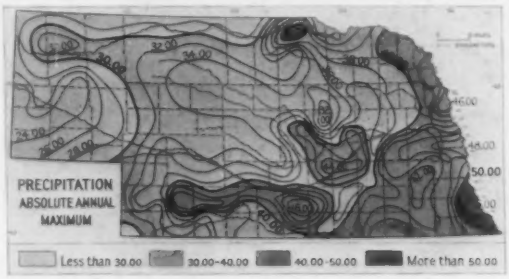
Winter, a composite picture of December, January, and February conditions, is the distinctly dry season. Range 2.33 inches, from 1.03 at Haigler to 3.36 at Auburn; median isohyet 2.25. Notice the east-west isohyetal trend with the one exception in the east. The westward looping on the interfluvial areas in general and south of the Platte in particular is most noticeable.

a topographical relationship. On the annual map, between Halsey and Omaha, the coördination of the minor loops of the respective isohyets appears too nearly perfect to be accidental. Omaha with the longest record of all the stations appears centered in a dry area. Whether this is the result of the length of the record or of other causes is not now clear.

The Platte Valley has long been regarded as an area of moisture.

receiving more rainfall than corresponding areas north and south. The maps show, for the first time, that actually the converse is true, especially to the south. The isohyets loop westward on the interfluves. The phenomenon appears faintly north and south of the Niobrara. Between the Platte and Republican it is outstanding on every map. The most plausible explanation[4] thus far suggested

Absolute annual maximum. Range 33.4 inches, from 23.75 at Mitchell in 1915 to 57.15 at Auburn in 1929; median isohyet 40 inches. This map answers the question, "What is the greatest amount of rain received at any one point in any one year?" Note the position of the median isohyet. The northwest section has never had a true flood year. The wettest year in the state was 1915.



Absolute annual minimum. Range 18.25 inches, from 6.81 at Culbertson in 1894 to 25.06 at Falls City in 1885; median isohyet 16. This map answers the question "What is the least amount of rain received at any one point in any one year?" It refutes several stock statements: never has a "complete drought covered the entire state"; moreover the eastern quarter has never failed to receive more than 15 inches of rain. Note the persistence of heavier precipitation south of the Platte. The driest year was 1894.

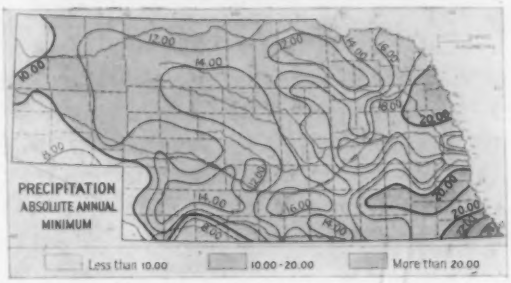


FIG. 4—Nebraska, extremes of precipitation. Stations with less than 15-year records have been disregarded.

involves a direct effect of topography despite the subdued nature of the relief. The interfluves in that part of Nebraska are broad and flat. This is particularly true of the great loess plain which extends without a major break from west to east for about 150 miles. Such flat interfluvial areas are without doubt more subject to rapid heating and cooling than adjacent rough or rolling surfaces, particularly if the latter are bluff-formed serrated valley edges such as those of the Platte and Republican. This makes the flat areas more subject to upward convectional air currents with their resultant thunderstorm type of rainfall, which is naturally more pronounced on long west-east flats because they parallel the general west-east direction of movement of cyclones. Since in the middle west the greater part of the rainfall is of the convectional type, it is reasonable to assume that such flat areas over a long period of time will receive more rain than adjacent areas of greater relief.

[4] Based on an unpublished suggestion made by Nels A. Bengtson, Professor of Geography, University of Nebraska, and presented with his permission.

MODERN ALBANIA: A REVIEW

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University of Rome

GEOGRAPHICAL knowledge of Albania in the modern scientific sense dates essentially from the period of the war, during the course of which various military services carried out work that remains today an indispensable foundation for extended geographical studies.

Surveys and Maps

Of first importance are the topographical surveys, the first in Albanian territory, carried out during the years 1916–1918 by the topographical service of the Austrian army for northern and central Albania, by that of the Italian army for southern Albania, and by the French army in the zone of occupation to the southeast about Koritsa. Later came the survey of the boundary zones carried out on the scale of 1:25,000 by the International Boundary Commission between 1923 and 1925. Not all these surveys have been published, but they have served as a basis for the excellent map on the scale of 1:200,000 compiled on a commission from the Albanian government by Herbert Louis, who has revised them on the ground, coördinating the material and filling in the gaps.[1] Louis' contoured map gives for the first time a precise representation of the principal relief features of Albania, particularly the so-called North Albanian Alps, culminating in the Maja Jezerce (2692 m.).[2] Among other things this map is notable for its representation of the glacial features that characterize more or less all the country where there is a considerable area above 2000 meters.[3]

The relief map has also served as the base for a geological map on the same scale elaborated by Ernst Nowack from his own surveys

[1] Herbert Louis: Die Neue Karte von Albanien 1:200,000 (Begleitworte zur Kartenbeilage III), *in* Sonderband der Zeitschr. Gesell. für Erdkunde zu Berlin, Hundertjahrfeier 1828–1928, Berlin, 1928, pp. 426–446, map in 2 sheets. The volume by Herbert Louis, "Albanien: Eine Landeskunde vornehmlich auf Grund eigener Reisen" (*Geogr. Abhandl. herausg. von A. Penck*, Ser. 2, No. 3), Stuttgart, 1927, may be considered as a commentary on the map. From this map with certain additions and corrections is derived the map on a scale of 1:1,250,000 that accompanies the article Albania in the *Enciclopedia Italiana*, Vol. 1, 1929—the best atlas map extant.

[2] This figure is not found on recent maps because it does not apply to a principal trigonometrical point. It is none the less certain that Maja Jezerce, entirely in Albanian territory, is the highest mountain of the Albanian Alps. The highest summit of the Korab (2769 m.) is on the boundary (see Fig. 1).

[3] Cf. E. Nowack: Die diluvialen Vergletscherungsspuren in Albanien, *Zeitschr. für Gletscherkunde*, Vol. 17, 1929, pp. 122–167.

and those of Baron Nopcsa for northern Albania.[4] Albania has thus come to possess a geological map of a sort that no other Balkan state to my knowledge has. According to the recent studies of Nowack the country may be roughly divided into nine morphological-geological zones as shown on the map, Figure 1 (inset).

Natural Regions

The recognition of geological zones affords also a basis for the division into geographical regions, but such division must take account also of other elements—morphology, climate, vegetation, etc. At the present time our knowledge of the climate is scanty, as Albania still lacks a network of meteorological observatories functioning regularly. The little that is satisfactorily known has been summarized by the writer in a recent work in which is set forth the great variety of climates the country presents even within its modest limits on account of the morphological fragmentation.[5] As for vegetation, we are better informed both by general works on the Balkan Peninsula as a whole and by more specific researches in Albania itself,[6] which also permit us to arrive at some conclusions about the climate. For example, a characteristic Mediterranean formation, the *macchia*, stops where the immediate influence of the sea ceases on the north of the flanks of the chain of Kruja and on the south on the seaward-facing slopes of the Acroceraunian Mountains. On the other hand it penetrates widely into the interior in the central region corresponding to the valleys of the Semeni and Shkumbi. The distribution of the broad-leafed woods and the richness of the pastures reveal a notable difference between northern and southern Albania in the rainfall. The former receives a moderate amount of rain even in the summer season while the latter has decidedly dry summers. In this regard the relief features that run along the right bank of the Shkumbi (Cermenika, Krabe) form a precise dividing line.[7]

Louis distinguishes four natural regions: lower Albania, Albanian

[4] Geologische Karte von Albanien on a scale of 1:200,000 by Dr. Ernst Nowack, Berlin, 1928, 2 sheets. As an exposition of this map Ernst Nowack has published a "Geologische Uebersicht von Albanien" (Innsbruck, 1929), although in only a few lithographic copies. For northern Albania the fundamental work is F. Nopcsa: Geographie und Geologie Nordalbaniens, *Geologica Hungarica, Series Geologica*, Vol. 3, Budapest, 1929. For the connection between these geological zones of Albania and those of other parts of the Balkan Peninsula, see the map on page 310 (Fig. 36) and pages 308 ff. of the volume by Otto Maull: Länderkunde von Südeuropa (*Enzyklopädie der Erdkunde herausg. von Oskar Kende*), Leipzig and Vienna, 1929.

[5] Cf. Roberto Almagià: L'Albania, Rome, 1930, pp. 40–46. The map on page 344 (Fig. 40) in the work by Maull cited above is deficient because it is founded on a source (Trzebitzky) dating from 1911: it does not take account of a series of very valuable observations made during the war period, particularly in the territory occupied by the Austrian troops.

[6] Cf. particularly L. Adamović: Die Vegetationsverhältnisse der Balkanländer, Leipzig, 1909; W. B. Turrill: The Plant Life of the Balkan Peninsula, A Phytogeographical Study, Oxford, 1929; Friedrich Markgraf: An den Grenzen des Mittelmeergebiets: Pflanzengeographie von Mittelalbanien, *Suppl. to Repertorium Specierum Novarum Regni Vegetabilis*, Vol. 45, Dahlem bei Berlin, 1927.

[7] This comes out particularly from the observations of Markgraf.

Epirus and its borders, the northern interior of Albania, southern interior Albania, the boundaries between the last two seemingly indicated by the ridge of the Cermenika and of the heights that continue to the east as far as the Drin.[8] This quadruple division takes account of morphology, climatic characteristics, etc., but is of value primarily in that it serves as a basis for further subdivision in the smaller individual regions which as a result of the fragmentation of the terrain are numerous (35).

Maull on the basis of the distinction applied to the Balkan peninsula as a whole between mountain and lowland regions recognizes an Albania of plains and hills (more extensive, therefore, than the "Lower Albania" of Louis), subdivided into three sections (region of Scutari, central region to the north of the Shkumbi, and the southern region, or region of Muzakija, etc.), and a mountainous Albania composed of two principal parts, the northern Albanian Alps and the central mountainous region separated from each other by a trough formed by the valley of the Drin, which with the neighboring elevated basins constitutes another subzone. This division of Maull's is, however, not very satisfactory, particularly for interior Albania.

The writer proposes to distinguish the following twelve natural regions, which are differentiated from one another both by economic circumstances and in respect to the distribution of population. They are shown on the map, Figure 1.

I. The mountainous country to the north of the Drin (North Albanian Alps). This is region of rough, high mountains with a rather sparse population (less than 25 inhabitants per square kilometer). The basis of economic life is pastoral; the few agricultural zones are concentrated on the floors of the principal valleys, which form enclosed isolated communities. This isolation has fostered the preservation of a tribal régime, which is still in full vigor.

II. The region around Lake Scutari with the plain of the lower Drin as far as Mati. The plain, covered with a deep bed of alluvial soil, is well cultivated in parts; and a larger area of cultivable land will be available when the watercourses have been better regulated. The population is relatively dense (more than 60 per square kilometer); the vicinity of the sea has at all times favored outside influences and a fairly high state of civilization.

III. The region between the Mati and the Shkumbi with the high basins of Tirana and Elbasan. The basin of Tirana, healthful and abundantly supplied with water, has become the political center of Albania; the Shkumbi is the central river of the country. In this region are concentrated the principal forces contributing to agricultural progress and the beginnings of industrial development. The adjacent maritime plain tends to form a single economic organism with the hinterland; in the port of Durazzo is concentrated the entire maritime movement. The principal centers—Tirana, Elbasan, Durazzo, Kavaja—are rapidly growing.

IV. The mountainous central region bounded on the west by the Kruja Range, on the south by that of Cermanika, and on the north and east by the Drin. This region has a large area of forests; but agriculture is nevertheless practiced, although for the most part in isolated patches. The population hence is much dispersed; there

[8] Compare the map by Louis, *op. cit.*, which is also reproduced in the article "Albanie" by H. Zondervan, *Tijdschr. Kon. Nederl. Aardrijksk. Genoot.*, Vol. 48, 1931, pp. 239–267.

are no large centers. Difficulty of access has contributed to the preservation of a strong feeling of autonomy among the inhabitants, who include the famous families of the Mirditi and the Matja.

V. The eastern mountainous region (east of the Drin) with the Koritnik, Korab, etc., ranges, and the high basins of Peshkopija and Dibra. Characteristic of this region, which contains the highest summits in Albania, is the contrast between the mountain slopes—steep and wooded or bare and precipitous at high altitudes and without habitations—and the basins and valley bottoms, well cultivated and settled. Where the population is thus concentrated the density must exceed 25 per square kilometer. This is the region that is most cut off from the political center of the state.

FIG. 1—Natural regions of Albania according to Almagià. For description see text. Scale of map 1 : 2,850,000.

The inset shows morphological-geological regions after Nowack. Reference: 1, coast zone Tertiary; 2, Tertiary basins of interior; 3, mountainous and hilly region (Eocene flysch with dorsal anticline of Cretaceous-Eocene limestone); 4, continuation of Dalmatian-Montenegrin chain (nummulitic limestone and flysch); 5, Ionian chain (Mesozoic limestone with included flysch basins); 6, Cukali mountain region of intense folding (Mesozoic-Eocene); 7, serpentine highland with Triassic rocks and limestone (Gosau) tablelands; 8, North Albanian Alps (Mesozoic limestone on Upper Paleozoic); 9, northeastern Albanian region of metamorphosed Triassic and Upper Paleozoic rocks.

VI. The coastal plain south of the Shkumbi (Muzakija) and the plain of Valona. This region is distinguished from that of the northern coastal plain (No. II) not only by the more distinctly Mediterranean climate but by a lower economic development particularly as regards agriculture. This is due in part to the irregular régime of the rivers, which are subject to floods that leave the soil waterlogged: hence much land is closed to agriculture. Until a few years ago *latifundia* predominated, and malaria is still widespread. Here are the winter quarters of the transhumance-practicing tribes and their flocks from the mountains of the interior; the sedentary population is sparse.

VII. The mountainous region of the interior, trenched by the upper Shkumbi

and limited on the east by the Jablanitsa range and its southern continuations and by the Ostravitsa; on the west by the Osum River. In this region also the pastoral industry is of great importance, while agriculture is limited to several broad high basins. The disposition of the valleys renders this region more accessible than the mountainous regions of the center and north. The population is concentrated in villages whose distribution is markedly influenced by the water supply.

VIII. The basins of the southeast (basin of Koritsa; shores of Lake Okhrida; Kolonia; plain of the upper Devoli). This region, which is given unity by the high, healthful basins with flat floors largely used for agriculture, is in reality the most important in the kingdom from the agricultural point of view. The population, widely disseminated, is dense (70–80 per square kilometer; in the basin of Koritsa around 90). Communications are easy with the neighboring Greek territory, and a lively commerce has contributed to the growth of the city of Koritsa and the other lesser centers. The basin of Koritsa also has certain prospects as regards mining.

IX. The hilly region between the Osum and Viosa (Malakastra, etc.). This is a region of Tertiary hills with a prevalence of clayey formations of mediocre fertility. The population is concentrated in compact villages; small landholdings predominate. The density of population (15–30 per square kilometer) corresponds to the modest resources.

X. The southern coastal range (Acroceraunian Mountains). These steep, dry, mountains with a karstic character are extremely limited in resources, and there are few landing places on the steep coast. The Acroceraunian peninsula is almost entirely uninhabited; to the south there are a few villages, nestling high above the steeply sloping coast in view of the sea.

XI. The southern interior mountainous region, cut through by the Viosa and its tributary, the Dhrinos. This region is formed by a series of longitudinal valleys separated by mountain chains. Settlement is concentrated on the floors and lower sides of the valleys, and agriculture is of the Mediterranean type. But the valleys also constitute natural lines of communication and traffic; the density of population rises to 50–60 per square kilometer.

XII. The extreme southern borderland. The coast is unhealthful and sparsely populated, except for the little port of Santi Quaranta; the interior basins, such as that of Delvino, offer much room for agriculture but now suffer the handicap of unfavorable conditions of water supply. The dry basins of the northern part are well cultivated with tree cultures of Mediterranean type and grains and are also densely populated (60 to 80 per square kilometer); the other parts suffer from poor drainage and malaria, and prospects of future development are bound up with reclamation.

The Census of 1930

The new Albanian government has instituted a statistical service, to which we owe among other things the publication of a statistical annual[9] and the taking of two censuses, one in 1923 and the other in 1930.[10] The population of the later census, 1,003,124, may appear somewhat exaggerated in comparison with the 1923 total given as 814,485. This last figure corresponds fairly well with various earlier calculations; the increase of 188,639 inhabitants in seven years, however, does not seem so excessive when account is taken of the fact that besides the natural increase there has been a settlement of

[9] Published from 1923 on. The last edition that I have noted is that of 1927, Th. Selenica, Shqipria më, 1927, Tirana, 1928.

[10] Population by districts is given in the issue of *Arbenia* of Tirana, for June 1, 1930.

refugees from Jugoslavia (2400 families, equivalent to about 10,000 persons, between 1925 and 1928 according to official data) and of the number of repatriated immigrants from America. The average density of the population resulting from the above figure is 36.5 per square kilometer. In order of density per square kilometer the population of the provinces is Tirana, 68; Durazzo, 49; Koritsa, 44; Berat, 41; Valona, 39; Elbasan, 38; Dibra, 36; Argyrokastro, 34; Scutari, 27; Kosovo, 23. I have attempted to map the density of the population from the data available in 1928.[11] N. M. A. Popp[12] has constructed another small map.

The Albanians as a folk have often been described, but today to observe the various types and forms of customs and costumes, habitations, and the like, one has to visit the less accessible regions where alone they survive.[13] Greater interest is now to be found in the attempts being made to give the new state a modern aspect, to favor the penetration of European cultures, to effect the utilization of economic resources, and to raise standards of living.

Economic Possibilities

On the conditions and economic possibilities of Albania much has been written from different points of view in recent years.[14] The geological map by Nowack on the scale of 1:200,000 also contains indications of all of the localities where useful mineral deposits have been recorded and serves to give a general idea of the potential mineral resources, but exploration in this direction cannot be said to have been completed.[15] Actually, if we except the Italian concession at Puka to the east of Scutari (where preliminary researches have been begun toward the exploitation of the copper deposits) and two concessions for the mining of lignite in the basin of Koritsa, the only enterprises regularly being operated are those of petroleum and other hydrocarbides that seem to be the products destined for the most favorable future. On the basis of the mineral laws of January, 1923,

[11] Almagià, *op. cit.*, pp. 248–249.

[12] N. M. A. Popp: O tară ospitalieră: Albania, *Bul. Soc. Regale Române de Geogr.*, Vol. 49, 1930, pp. 140–195.

[13] Two recent books which contain good descriptions and rich illustrative material may be pointed out to the reader:

Friedrich Markgraf: In Albaniens Bergen, Stuttgart, 1930.

A. Bernatzik: Europas vergessenes Land, Vienna, 1930. Markgraf is a botanist who has traversed certain of the harsher interior zones that have been little visited to date, such as the high basin of the Shkumbi, the Matja, and the basin of the Drin. He has made particular studies on vegetation, but his book is rich also in ethnographic observations. The book by Bernatzik is valuable especially for its magnificent photographs, numbering over 100. The text is brief.

[14] See: Antonio Baldacci: L'Albania (Publs. Istituto per l'Europa Orientale, Ser. 2, No. 17), Rome, 1930, the most voluminous work that has recently appeared on this country and one in which the economic part (pp. 312 ff.) is the best; Roberto Almagià, *op. cit.*; F. Wallisch: Neuland Albanien, Stuttgart, 1931; A. Vierthaler: L'Albania, Fattori fisici e antropici del suo sviluppo economio, Gorizia, 1931; and particularly, F. Tajani: L'Avvenire dell'Albania, Milan, 1932.

[15] The small map on page 211 of my book is based on Nowack with certain additions.

thirteen concessions were granted before the end of 1929, of which the most important were those of the Italian State Railway. These include a total area of about 165,000 hectares, divided into various lots in the provinces of Valona and Berat. Before the end of 1930 sixteen wells had been excavated to a depth of about 10,000 meters; other explorations are under way. The most promising zone seems to be that of the middle Devoli. Other Italian and foreign companies receiving concessions have barely begun operations with results that are not particularly promising. The Società Italiana delle Miniere di Selenizza is exploiting the famous ancient bituminous mines formerly held by a French concession. The product is of quite good quality for street paving and for this purpose is exported, for the most part already refined in the plants of the company itself, from the port of Valona where there are loading facilities. But the amount extracted does not exceed 6000 tons a year.[16]

On the agricultural future of Albania we quote the restrained judgment of F. Tajani: "Albania . . . is a country endowed with resources that have not been sufficiently utilized. With modern methods of cultivation it could support normally a population considerably larger than the actual population, and there are probably no inconsiderable riches in the subsoil. But it is also true that to bring agriculture up to the level it has reached in other civilized countries, in addition to enterprise and technical capacity, a very large capital would be needed for machinery and supplies. There is not enough of this. Even if there were, the products thus obtained would not be marketable because of the lack of roads. Hence, if we are to think of a productive Albania, at the very beginning the problem of means of communication must be solved. Furthermore, for the extension of cultivation a radical solution would unquestionably call for control over the waters which today are quite without rule and curb. There exist, it is true, very fertile plains like the Muzakija, but they are cursed with malaria and are uninhabitable. To make them sanitary would involve heavy expense, with long preparation and skill and method in carrying out the work."[17]

An obstacle to the development of modern agriculture lies in the areas occupied by *latifundia*, particularly numerous on the plains of the center and the south. Some are the properties of rich families; others belong to the state and to ecclesiastical bodies. These large estates remaining undivided from generation to generation are ill utilized and give poor yields. On the other hand, the condition of agriculture is much better in the southeastern region in the basin of Koritsa where landed property is closely subdivided and whither

[16] Among the most recent notices on mineral studies in Albania reference may be made to the collection in the Italian review *L'Industria Mineraria;* L. Maddalena: Studi e lavori per le ricerche di petrolio in Albania, *ibid.*, 1929; A. Moschetti: Le miniere in Albania, *ibid.*, 1930.

[17] F. Tajani, *op. cit.*, pp. 53–54.

emigrants come back enriched from America. To remedy the evils of the *latifundia*, laws have recently been passed providing for the partial expropriation of lands belonging to the great proprietors and distribution of them among poor farmers or among persons who have carried out studies of farming. Among the many provisions is one stipulating the founding of a national agricultural bank to assure agrarian credit to the class of small proprietors thus created.[18] It should be remembered that the most profitable regions for agriculture are those of the coastal plains of central Albania where, as Tajani points out, great reclamation operations are required.

An example of what can be achieved is afforded by a concession of the Ente Industrie Agrarie dell'Albania which has obtained about 3000 hectares of land near Shiak, three kilometers from the Durazzo-Tirano road. A large part of these lands, which were first left to pasture, has been plowed up with mechanical plows and put under cultivation. A system of drainage canals has been laid out, houses have been built for the settlers, and a pumping plant raises the waters of the river Arzèn for irrigation. The products from the 410 hectares already cultivated are all of superior quality from every point of view and are readily marketed in Durazzo and Tirana. But such enterprises require large capital and abundance of labor, which up to the present has been lacking, while legislation in force forbids the importation of workers from abroad.

For the immediate future Albania can probably count on an improvement of its animal production. Stock raising is a traditional occupation, and calculations in 1927 as to the wealth in animals gave very considerable figures, superior to those with which the country is commonly credited: about 380,000 cattle, a little less than a million sheep, 1,330,000 goats, 120,000 horses and asses, as well as 25,000 hogs and 10,000 buffalo.[19] These figures are perhaps a little exaggerated, but in any case they indicate that the country has a large capital from which excellent results could be obtained when traditional practices are perfected and modern dairying methods have been introduced.

Communications

All those who have studied recently the economic conditions of Albania agree that one of the most pressing problems is the creation of a network of road communications. Under Turkish rule it may be said Albania had no carriage roads. The first road building on a large scale was undertaken during the World War by the Italian,

[18] A thorough study of the agrarian question will be found in Giovanni Lorenzoni: La questione agraria albanese, Florence, 1930.

[19] The official data are in the statistical annual cited in note 9. The table of distribution by provinces is given in Almagià, *op. cit.*, p. 207.

German, and French corps of occupation. But that work reflected military exigencies, and several of the trunk roads then built were subsequently abandoned. In the last few years, however, the government has made considerable progress with the coöperation, financial and technical, of Italy, particularly of the Società per lo Sviluppo Economico dell'Albania (S.V.E.A.). All the principal urban centers are now joined by roads fit for automobile traffic, even though the mountainous nature of the country necessitates rather roundabout routes in places.

By carriage roads Albania can be entered from the neighboring states, from the north (Podgoriza and Antivari), from the northeast (Prizren), from the east (Dibra, Okhrida), from the southeast (Floria), and from the south (Janina). Bridges, formerly lacking, have been built, and in some cases remarkable difficulties have been encountered in their construction. The creation of this highway network has contributed to the political unification of the country in which there exists, as is well known, a marked cleavage between the inhabitants of the north (Ghegs) and those of the south (Tosks). The capital, Tirana, will soon be joined to the port, Durazzo, by a railroad constructed principally by Italians with track gauge and rolling stock the same as those of the Italian railroads. The construction of the port of Durazzo is in itself a considerable undertaking. Begun in January, 1928, it will be finished at the latest in 1933—indeed a part is already in operation. The water surface of the port will be marked off by two breakwaters, one for a protection against the west and south winds, the other against winds from the east. The entrance is 200 meters wide. There will be 700 meters of quays with a depth of 6 meters alongside and 500 additional meters of quays with a depth of 3 meters. The quays will be served by the rails of the Durazzo-Tirana railway which it is anticipated will surely be in operation in 1933.

The building of highways has already produced, although on a small scale, the beginnings of automobile traffic, while the scenic attractions and "local color" of the country are drawing an increasing tourist trade. The rebuilding going on in the large cities is, however, fast destroying the oriental appearance they had preserved up to a few years ago. Guidebooks for the use of tourists have already been published,[20] and the picturesque mountainous region of northern Albania, especially the Albanian Alps, has begun to attract alpinists.[21] The country has also regular aerial services both for the interior and to Italy (Valona to Brindisi).

[20] The best is that of Leon Rey: Guide de l'Albanie, Office de Tourisme en Albanie, Paris, 1930.

[21] Two recent mountaineering expeditions have added considerably to our knowledge of the Albanian Alps. See G. Heinsheimer, E. Hofmann, H. Schatz: Eine Bergfahrt in das nordalbanische Gebirge (1930), *Zeitsch. Deutsch und Oest. Alpenvereins*, Vol. 62, 1931, pp. 158–178 and Missione Floridia-Allegri sulle Alpi Albanesi, 1931, *Natura*, Milan, 1931, pp. 165–168.

Other Features of Modernization

Roads, bridges, port works, new municipal buildings, and the automobile traffic are all modern aspects of Albania which make an immediate impression on the visitor from abroad. But it would be unjust to overlook the modernization also in progress with the introduction of European legislation, the reorganization of justice, the abolition of the traditional vendetta, the institution of a regular procedure for the raising of taxes, for the creation of a ground tax, etc. Little by little the resistance of the inhabitants attached to existing conditions maintained or tolerated throughout centuries is being conquered. A notable movement for educational reform has risen—the founding of schools on the European model, the sending of the more intelligent young people to study abroad in Italy or France, the diffusion of printing, and the like.

For us who have for centuries been accustomed to economic, social, and cultural forms characteristic of European civilization it is peculiarly instructive to see how these forms, slowly and in the face of many difficulties, are being introduced into a country so small and so close to our own.

NOTES ON SEICHES AND CURRENTS IN GREAT BEAR LAKE*

A. E. Porsild

IN the course of an investigation of grazing possibilities in the northwestern part of the Mackenzie District, North West Territories, undertaken in the interest of the North West Territories and Yukon Branch of the Department of the Interior, Canada, from 1926 to 1928, the writer, accompanied by his brother, Robert T. Porsild, spent the period from March to September, 1928, in the Great Bear Lake region.[1]

During this period, in addition to the botanical work, observations were made on seiches and currents as well as on the general physiography of the lake basin. Since records and observations of seiches in Canada are few, and, to my knowledge, none have ever been made on any of the northern lakes, it is hoped that these brief notes may be supplemented and augmented by future travelers in this region. Much interest has lately been focused on it in consequence of the recent discoveries of copper and nickel ore.

The lake with an area of about 12,200 square miles is generally considered to be the fourth largest of the lakes of North America and the largest of the lakes wholly within Canada. It consists of five arms radiating from a common body, and its greatest diameter is from southwest to northeast—from the head of Keith Arm where Great Bear River issues to the head of Dease Arm. This distance is given by Richardson as 150 statute miles, but we found it by sled odometer to be somewhat longer, 184 statute miles, while from the head of Smith Arm to the head of Dease Arm is slightly less.

The existence of "tides" or seiches in Bear Lake was first brought to the attention of the writer by A. W. Boland, for many years a resident in the Bear Lake region, to whom the writer is indebted for much valuable and accurate information about the country. During his residence on the lake, Mr. Boland had often observed rhythmical rise and fall in the water level. He described numerous places where to his knowledge, either from personal observation or from information received from Indians, such pulsation occurred and was known to set up a considerable current. The writer spent several months

* Published by permission of the Director of the North West Territories and Yukon Branch of the Department of the Interior, Ottawa, Canada.

[1] For an account of the expedition see A. E. Porsild: Reindeer Grazing in Northwest Canada, published by the Department of the Interior, North West Territories and Yukon Branch, Ottawa, 1929.

in Dease Arm and had occasion to make personal observations on the seiches that are very noticeable near the foot of the arm.

Great Bear Lake has long been known to be very deep, although previously no actual soundings had been made. On our several traverses of the lake 65 soundings were taken. The average depth was found to be between 50 and 60 fathoms. Dease Arm is rather shallow,

FIG. 1

its depths varying from 15 to 45 fathoms, as it has two or three submerged ridges parallel to the shores. The arm is funnel-shaped and is about 50 miles long and 20 miles wide at the entrance. Near the head of the bay a large island, about 12 miles long, nearly closes the innermost part, leaving a narrow and quite shallow passage on each side. Mr. Boland had found that in mild winters some of these "narrows" remain free from ice or at least partly open because the water is continually rushing back and forth. This current was first noticed by the writer on April 20, when a fish net was set in the north narrows near the Old Fort Confidence. The temperature for the previous month had been low, reaching 20° and 30° F. below zero almost every day. No open water was found then, although it was noticeable that the ice was nowhere as thick as in the rest of the lake. Where the net was set the ice was less than one foot thick and a light outgoing current was noticed. The following day a somewhat stronger ingoing current was observed. In the first week of May open water had formed in the narrowest place, which is about 200 yards wide. A shoal of boulders extends across, with no more than eight feet of water.

In order to obtain more exact measurement of the seiche, in the latter part of May a large hole was cut in the ice near the foot of the bay and about 200 yards from the shore. The ice was three feet thick and the water six feet deep. A heavy pole, 12 feet long, was driven about five feet into the hard clay bottom, and a graduated rule was nailed to the top reaching well down into the water. A tent was put up over the hole to afford shelter for the observer and to prevent ice

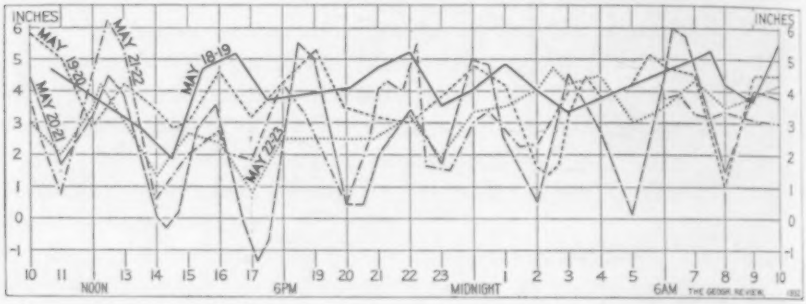

FIG. 2—Graph showing hourly readings of water level at the foot of Dease Arm, Great Bear Lake, from May 18 to May 22, 1928.

from forming around the pole at night. For a period of five days hourly readings were taken of this "tide gauge." During this period eight more or less distinct daily "tidal waves" were observed having a mean amplitude of about four inches, with extremes of one and a half and six inches between two successive readings and with an absolute maximum amplitude of nearly 8 inches. Owing to the lack of an instrument of sufficient accuracy no barometric readings were taken. During the period of observation it was noticed that the rise and fall of the water level caused the ice to crack parallel to the shore of a small group of rocky islands half a mile away. The formation of cracks was always accompanied by booming as from gunfire or from detonation of heavy charges of dynamite. Towards the end of May, when the ice in the rest of the lake was but slightly affected by thaws, the narrows on both sides of the island were almost completely free from ice.

During the month of July seiches were noticed on the north shore of Bear Lake at various places. In one place where a small lake about a quarter of a mile long was connected with the main lake by a narrow channel 50 feet wide and two or three feet deep a rise and fall of the water in the small lake was observed to vary from two to four inches. The water seemed to be continually rushing in and out of the lake, changing direction every hour or two, or roughly twice as often as at Dease Arm.

The strongest current caused by the seiches was found in the southeast corner of Great Bear Lake where a fairly large body of water.

known as Conjuror Bay, is separated from the waters of McTavish Arm by the large rocky Richardson Island. The southern entrance to Conjuror Bay is 400 to 500 yards wide and several fathoms deep. Several small rivers empty into this bay, and the outgoing "tide" is noticeably stronger than the ingoing. At the narrowest place this "tide rip" looked like a rapid in a river with a current running from four to six miles an hour. Mr. Boland informed the writer that ice never formed in this place, even in the severest winters.

The season apparently has little or no effect on the oscillation of the waters of Bear Lake, although during the period of open water the rise and fall is somewhat obscured by waves and by the banking up of water on the lee shore as the result of wind. In midwinter, when the daily change of temperature is slight and when the whole lake is covered with an unbroken sheet of ice seven to eight feet thick, the influence of air currents is probably infinitesimal.

It is surprising that this phenomenon escaped the notice of such keen observers as Sir John Richardson and Sir John Franklin; the former spent two winters on Great Bear Lake, having his second winter quarters at Fort Confidence. Nor have any records been found in the reports of later travelers in that region.

A NOTE ON THORNTHWAITE'S NEW CLASSIFICATION OF CLIMATES

William T. M. Forbes
Cornell University

TO a student of biological distribution, Thornthwaite's recent "Climates of North America"[1] is of particular interest; for the effective humidity, which may be indicated by the relative humidity or by the relation of precipitation and evaporation, is rarely given in either form in Weather Bureau reports. Thornthwaite's formula, giving a means of calculating P/E from easily obtained data, then fills a serious gap. On comparing his map with known types of distribution, there appears to be a close coincidence over the greater part of the country; but on going over the Northeast, which is the part best known to me personally, I noticed two types of areas in which there seemed to be no visible correspondence between known distributions and the districts given on the map. Firstly, the mountain areas were very imperfectly represented if at all, and secondly the humid strip along the coast did not appear.

High Altitude Climates in the Northeast

A comparison of the factors taken up in the text made the reason for the first omission obvious: there are no Weather Bureau stations or long series of recent records at any point of high altitude in the entire Northeast, so naturally a map based on weather reports only and not adjusted for topography or known biological distributions in the intervening areas would fail to show the mountain climates. For Mt. Washington, older records show a precipitation of 82 inches, with a summer maximum and low temperatures, giving a climate which Dr. Thornthwaite has kindly calculated as P/E 330, T/E 13.75. This is tundra and checks with the actual climate of the summit. There are no data for the slopes just below the summit, but undoubtedly the coolest temperature zone on the mountain is still far more humid than Thornthwaite's map would indicate.[2]

The Humid Coastal Strip

The reason for the humid coastal strip became obvious on analyzing the meaning of the formula for estimating the evaporation on page 639. If we solve the equation for E, we get

$$E = .087 \frac{(T-10)^{\frac{10}{9}}}{P^{\frac{1}{9}}}$$

In other words, the evaporation varies directly as the temperature (approximately) and has a small inverse dependence on the precipitation. This obviously

[1] C. W. Thornthwaite: The Climates of North America According to a New Classification, *Geogr. Rev.*, Vol. 21, 1931, pp. 633–655.

[2] *U. S. War Dept., Rept. of the Chief Signal Officer* [now U. S. Weather Bur.] *for 1880*, Paper 16: Monthly and Annual Amounts of Precipitation . . . ; Paper 18: Maximum, Minimum and Mean Temperatures; *for 1881*, App. 18 (temperature) and 21 (precipitation); *for 1882*, App. 20 and 34; *for 1883*, App. 20 and 40; *for 1884*, App. 28 and 48; etc. See also *U. S. Weather Bur. Bull. W*, 2nd edit., 1926, section 105, p. 5.

means that there is no effective humidity not dependent on local precipitation; a formulation that is not unreasonable for continental localities but obviously is not a proper assumption where there are large bodies of water in the vicinity.

We find, in fact, that the series of records on which Thornthwaite builds up his formula are continental, with a single exception, Crowley, La., which no doubt disappeared in the process of averaging.

Correction for the Coastal Areas

We may try to evaluate the necessary correction to allow for the vicinity of the sea, and resulting humidity not dependent on rainfall, by repeating Thornthwaite's process of derivation while limiting ourselves to stations near the sea. I have found four stations: Crowley, La.,[3] just mentioned, Pleasantville and Runyon, N. J.,[4] and Gardiner, Me.,[5] none of them actually on the sea, but near enough to give the direction and hint at the amount of the correction.

This calculation is most easily made graphically. On Figure 1 I have plotted the logarithm of the monthly precipitation divided by the temperature against the logarithm of the precipitation divided by the evaporation and have drawn the line corresponding to Thornthwaite's equation (the solid diagonal line). A few sample continental stations are indicated by open symbols (circles for Biggs, Cal., triangles for Moro, Ore., and squares for Archer, Wyo.). It can be seen that they fall very nicely about the line and verify Thornthwaite's equation. On the other hand, if we take our four coastal localities, indicated by solid symbols (triangles for Crowley, La., squares for Gardiner, Me., circles for Pleasantville and crosses for Runyon, N. J.), we find they lie as a whole well above the line and are obviously grouped in a different manner. If we try to represent them by a straight line through the center of the group (dashed line), the formula indicated is roughly

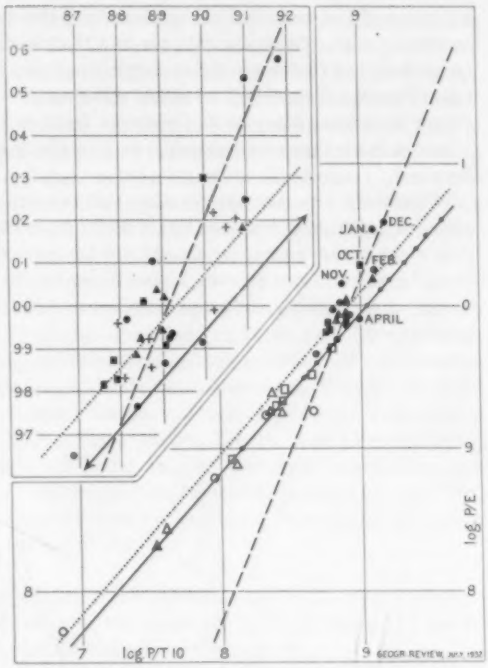

FIG. 1—Logarithmic plot of relation of temperature, precipitation, and evaporation. The ordinate is precipitation divided by evaporation; the abscissa is precipitation divided by temperature above 10° F. and should read log P/T–10.

$$\frac{P}{E} = 400\left(\frac{P}{T\text{-}10}\right)^{2.36}$$

The application of this formula would require a new nomograph and recalculation

[3] R. E. Horton: Results of Evaporation Observations, *Monthly Weather Rev.*, Vol. 49, 1921, pp 553–566.

[4] Climatological Data, *U. S. Weather Bur. Publs.*, New Jersey section (years 1924–1928 were used).

[5] *U. S. Weather Bur. Bull. W*, 2nd edit., 1926, section 105, p. 2.

from the original data. We can make a rough approximation by ignoring the points for January and February (the two uppermost), as they probably have little effect on the animal and plant life, and drawing a line parallel to the solid line through the remaining points (dotted line). This will give a formula with the same exponent of 10/9 used by Thornthwaite and make it necessary to change only the multiplier, which comes out 16.6 instead of 11.5, a 40 per cent increase. Hence we can get a rough estimate of the correct P/E values along the coast by multiplying Thornthwaite's values by 1.40. Applying this, we find that A-climates extend along the coast south to below Cape Hatteras, with a single small gap in southeastern Virginia. The map then should be modified to show climates of the AB′r type along the coast of North Carolina, Maryland, Delaware (and in fact Cape May, N. J.), and AC′r climates from there continuously to join the area on the coast of Maine and Nova Scotia.

Obviously I cannot say whether this correction applies to all coastal and insular areas, or only to the Atlantic, but it seems most likely to be general. It is also obvious that strictly the correction should not be applied in a lump to certain stations but should grade off from an even higher figure on the actual coast and coastal islands, to merge imperceptibly into the true continental formula perhaps a hundred miles inland.

AMERICAN GEOGRAPHICAL SOCIETY

The March Meeting. The regular monthly meeting of the American Geographical Society was held on March 22, 1932, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. Dr. James Mackintosh Bell, of Ottawa, delivered an illustrated lecture on "The Great Lakes of the Far Canadian Northwest." Dr. Bell has carried out extensive explorations in northwestern Canada. He described the physical character of this remote region lately come into prominence as the result of mineral discoveries and depicted the life of the inhabitants, aboriginal and European. Some of his experiences in the region are recounted in his book "Far Places," 1931 (see also his paper "Great Slave Lake," *Geogr. Rev.*, Vol. 19, 1929, pp. 556–580).

The April Meeting. The regular monthly meeting of the Society was held on April 26, 1932, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. Sir Hubert Wilkins in a lecture entitled "By Submarine to the Arctic" related the experiences of the Wilkins-Ellsworth Transarctic Submarine Expedition of 1931 (see *Geogr. Rev.*, Vol. 22, 1932, pp. 156–157). This expedition was sponsored by four scientific institutions: The Woods Hole Oceanographic Institution, the Norwegian Geophysical Institute, the Carnegie Institution, and the American Geographical Society. Sir Hubert explained its purpose and outlined the scientific results now in the process of being worked out. Some striking motion pictures were shown of conditions under the ice.

Elections of Fellows. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 38 candidates who were duly elected as Fellows of the Society.

The Yale North India Expedition, 1932–1933. The Society is participating in the work of the Yale North India Expedition which, under the leadership of Dr. Hellmut de Terra, is now in the field. The program of the expedition is comprehensive, reflecting the key importance of the area in biological and ethnographical as well as geological and geographical problems. The geographical work of the expedition will include the mapping of many hundreds of square miles of unexplored country north of the Himalayas in the eastern Karakoram and the bordering plateau region of Tibet. It is thus hoped to solve a problem of outstanding geographical importance for Asia—the possible connection between the Karakoram and Trans-Himalaya. The map is also needed as a base for the physiographic and geologic studies with which it is hoped to elucidate the structure and origin of the world's greatest mountain range.

Dr. de Terra, formerly of Berlin, now of Yale University, has already carried out explorations in adjoining regions as a member of Trinkler's expedition of 1927–1928. With the results he then obtained, the full report of which is just issued, "Geologische Forschungen im westlichen K'un-lun und Karakorum-Himalaya" (Wissen. Ergebnisse der Dr. Trinklerschen Zentralasien Expedition, Vol. 2, 1932, to be reviewed in the *Geogr. Rev.* for October) his current work will be tied in. Dr. de Terra's party includes his wife, as photographer, Dr. E. G. Hutchinson, biologist, and Mr. E. G. Lewis, vertebrate paleontologist, both of Yale University. For the topographic mapping the expedition is fortunate in the attachment of Khan Sahib Afraz Gul Khan of the Survey of India. The Khan Sahib was attached to the expeditions of

Sir Aurel Stein, his contributions to which have been recognized by the Royal Geographical Society in the award of the Back Grant (1926), and the Visser-Karakoram Expedition. The Survey of India is further coöperating with the loan of instruments.

In a letter from Dr. de Terra to the Society dated March 16 he says: ". . . We shall start around May 15 from Srinagar and proceed to Leh in Ladakh. At the beginning of June we shall try to cross the Ladakh Range north of the Indus, and here some 30 miles west of Shyok the surveying will start. From that place the mapping will be continued south of the Changchemno Valley and north of the Panggong Lake across the Tibetan border towards the Dyap-tso. The total area will be over 2000 square miles, and the Khan Sahib thinks he will do some 3400 square miles. The maps will be later issued by the Survey, while the geographical and morphological results will be entrusted to your *Review*. We shall survey and investigate exactly in the eastern continuation of Mr. Visser's latest field of exploration. . . . We start tomorrow for Srinagar, where Hutchinson is going to study lake biology and I want to tackle the Pleistocene folding in the Kashmir Valley and its geomorphological conditions. The paleontologist was left in the Siwalik-formations south of here. . . . "

And under date of April 8:

"At present I am working out the geology and geomorphology of the Kashmir basin, which will keep me busy until we start for Ladakh; and I intend after our return to resume work on it until late November. Hutchinson is doing able work on the character of the lake faunae around here, which will help to confirm certain geological conclusions as to the origin and history of the lake basin and of the southernmost Himalayan Range. I found the first paleolithic implements right on top of the clay beds and excavated hundreds of plant remains which already prove a warmer climate than is to be found today. Moraines on top of the clays show the interglacial character, and all the lake terraces seem to be tilted along the southern flank—probably dragged along with the young uplift of the Pir Panjal Range."

Recent Publications

Pioneer Settlement. The companion volume to "The Pioneer Fringe" entitled "Pioneer Settlement" has now been issued (*Amer. Geogr. Soc. Special Publs. No. 13* and *14* respectively). In it twenty-six specialists representing twenty-one institutions in ten countries present the varied problems of settlement by different nations and races upon the world's far-flung frontiers. Each paper is based on the author's first-hand acquaintance with the land he describes. Thus the account of the pioneer belts of Australia reflects the author's field studies over a period of twenty-five years in both the nearer and the remote regions of inner Australia. Canadian economists, historians, and sociologists have drawn upon recent special research in presenting the vigorous pioneer advance of the Canadian Northwest. Two of the leading authorities on the "native question" in southern Africa write on that subject, and other students of pioneering in that land describe the advancing fringe of settlement on the borders of the subtropical highlands. Field studies, again, are the basis of a group of papers of special current interest on Manchuria and Mongolia, where the tide of settlement has flowed more strongly in the recent past than in any other part of the world. And it is surprising to what remote stations modern settlement has reached along the Andean border of South America.

The studies were made under the joint auspices of the Social Science Research Council and the American Geographical Society. The volume includes 470 pages and is illustrated with nearly one hundred maps and diagrams.

Millionth Map of Hispanic America. Four new sheets of the Map of Hispanic America on the scale of 1 : 1,000,000 in addition to those announced in the annual

report published in the April issue of the *Review* are now available, making a total of 42 published sheets.

The new sheets are sheets North F-14 (San Luis Potosí), South A-23 (São Luiz), South C-22 (Rio Tocantins), and South L-19 (Comodoro Rivadavia). The San Luis Potosí and Comodoro Rivadavia sheets are of particular interest. The former covers the oil-bearing region of Mexico that centers around the port of Tampico and the northern border of the densely populated central states of the republic, while the latter completes the sheets of the map covering both the Argentine and Chilean sections of Patagonia.

The Bibliographie Géographique for 1930. The fortieth issue of the *Bibliographie Géographique* is now ready for distribution in the United States by the American Geographical Society.

In calling attention to this publication it may be well to remind our readers of the unique character of the bibliography in the geographical, indeed one might almost say in the scientific, field at large. The bibliography appears annually and is strictly limited to current literature, including books, periodical articles, government and state publications, and maps. The selection of material is critical, and brief critical notes or references to reviews in outstanding geographical periodicals are added to most of the titles. The bibliography is international in scope. In accordance with an arrangement concluded in 1924 between the American Geographical Society and the Association de Géographes Français the Society began participation in the work. In the latest issue the Association de Géographes Français has had the coöperation of the Comitato Geografico Nazionale Italiano, the Royal Geographical Society, London, the Société Royale de Géographie d'Égypte, the Société Belge d'Études Géographiques, and the American Geographical Society.

GEOGRAPHICAL RECORD

NORTH AMERICA

Glaciation in Alaska. The existing glaciers of Alaska, which cover less than 20,000 square miles or rather more than three per cent of the area of the Territory, represent the latest phase in what, says Capps, may be a continuous history of glaciation since the beginning of the Pleistocene (Stephen R. Capps: Glaciation in Alaska, *U. S. Geol. Survey Professional Paper 170-A*, 1931). The present-day glaciers are practically confined to the mountains of the south and southeast, where relief is great and snowfall heavy. The Brooks Range in the north attains heights of 8000, possibly 10,000 feet; but precipitation is scanty, and there are only a few small glaciers. These two mountain areas were the chief centers of glaciation during Pleistocene time, probably during several stages, certainly during the culminating Wisconsin, stage. The mountain glaciers grew and coalesced so as to form almost continuous ice caps. Aridity kept a large area of the interior unglaciated (two plates, scale 1:5,000,000, show existing glaciers and the extension of Wisconsin, pre-Wisconsin, and pre-Pleistocene glaciations and direction of flow).

The comparative recency of the great ice invasion is suggested by the freshness of the glacial evidence. An approach towards definite dating is suggested by an estimate based on the rate of peat accumulation which is on the same order as those for the retreat of the Wisconsin continental ice sheet (30,000 to 65,000 years). It is also estimated that over the entire glaciated area at the time of maximum glaciation the ice averaged half a mile in thickness; and, from the existence of deep channels across the coastal shelf and glacial smoothing on islands, it is believed that the ice reached farther out to sea than Tarr and Martin concluded.

Among the effects of glaciation Mr. Capps notes the influence of ice scour in widening, deepening, and straightening the great fiord formed by Chatham Strait and Lynn Canal (compare Lawrence Martin and Frank E. Williams: An Ice-Eroded Fiord, *Geogr. Rev.*, Vol. 14, 1924, pp. 576–596) and various drainage anomalies—capture phenomena in the intermontane basin between the Chugach and Alaska ranges and the uncertain watershed through the mouth of the Delta Glacier, the waters issuing from which flow at times by way of the Yukon to Bering Sea, at times by way of the Copper River to the Pacific: "a salmon could conceivably ascend the Copper and Gulkana Rivers, enter the head of the Delta, and descend to Bering Sea, crossing a great mountain range on the way."

Highway Transportation in the West and Colorado Mountain Passes. An effective picture of road transportation in the western United States is presented in the "Report of a Survey of Traffic on the Federal-Aid Highway Systems of Eleven Western States 1930" (Washington, 1932). Maps in color show intensity of traffic flow and density of population (five grades, from less than 3 to more than 20 per square mile), including one for the area as a whole, over one-third of the entire country, on a scale of 1 inch to 50 miles and maps for the individual states on varying but larger scales. With the tables and graphs one readily appreciates the influences of climate and topography. The survey was carried out for the period September, 1929, to October, 1930. California had over one-third of the total daily vehicle mileage, with foreign (i. e. outside of the state) passenger traffic relatively small; Washington, Nebraska, Colorado, Oregon followed in intensity of traffic flow. The most traveled route was U. S. Highway 99 from El Centro in southern California to the Canadian border.

The effect of climate is well expressed in the ratio between summer and winter traffic. In Arizona passenger-car traffic varies only by 7 per cent; in Wyoming the severity of the winter is reflected in a variation of 89 per cent. Truck traffic is naturally less responsive than passenger traffic to weather conditions. In parts of the south winter tourist traffic is well above the average for the year.

Among topographic effects one may note the influence of the north-to-south-trending ramparts of the Rockies in Colorado. The intensity of north-south traffic between the populous centers east of the front range contrasts with the transmontane circulation across the state. Also noteworthy is the greater intensity of east-west traffic north (through Cheyenne) and south (through Santa Fe) of the state. The mountain passes control the location of routes in a striking manner. Ralph H. Brown has compiled a list of Colorado mountain passes and classified them according to function (Colorado Mountain Passes, *The Colorado Mag.*, Vol. 6, 1929, pp. 227–237, with map on a scale of one inch to 40 miles. See also the map on a scale of one inch to 24 miles in the *Colorado Year Book*, 1931, opp. p. 28. Transmontane Routes of Colorado, *Econ. Geogr.*, Vol. 7, 1931, pp. 412–424). He enumerates 135 passes—the term is strictly applicable to a practicable way over a range—74 are trail routes, 11 are abandoned roads, 26 are modern automobile highways, 13 are used by railroads. Maps locate the passes and illustrate the way in which the route pattern mirrors with remarkable fidelity the major peculiarities of stream drainage. The most important route is that which, entering the mountains from Canyon City (south of Colorado Springs) and proceeding up the Arkansas River, crosses the continental divide by the Tennessee Pass (10,424 feet), a route of which Frémont's 1845 expedition is the first recorded traverse. During the summer the intensity of traffic is greater by the trunk highway west from Denver over the Berthoud Pass (11,315), but this pass closes in December. The Tennessee Pass is kept open the year round.

FIG. 1—Important highways of the west as revealed by the flow of traffic. Reproduction on a reduced scale of Figure 7 in the transportation survey report. Average daily "foreign" traffic, the width of the line indicating the traffic density.

The Trail Smelter Question. Peculiar topographic and climatic conditions have so magnified the harmful effects of the sulphur fumes discharged from the smelter at Trail, British Columbia, that the question has become one of international importance.

The Trail smelter is located about ten miles up the Columbia River from the international boundary. As the result of the treatment of ores, particularly lead and zinc, at this plant, 250 million pounds of sulphur were produced in 1928 alone, of which 94 per cent was discharged into the atmosphere as sulphur dioxide gas. The gorge of the upper Columbia River, a narrow valley paralleled by hills rising 2000

feet above the river, not only hinders the lateral distribution and thus prevents the normal dilution of the fumes, but actually acts as a conduit leading them down the valley, into the United States.

Climatic factors also facilitate the drift of the fumes into the United States. As shown by continuous records of wind direction and velocity and thrice-daily pilot-balloon tests made by the official observer established by the U. S. Weather Bureau at Northport, Wash., in May, 1929, the prevailing direction of the surface wind is northeast to southwest down the Columbia River basin. The average wind velocity has been found to be about four miles an hour, which accounts for the long persistence of the gas at various localities, once it has arrived. During the early morning hours, when sulphur dioxide fumes were most often noted by the government investigators, the relative humidity was usually 60 to 75 per cent. This is particularly harmful during the crop growing season because the presence of moisture in the air favors acute sulphur dioxide burning of vegetation.

It has been found that the fumes drift into the state of Washington on an average of 20 days out of a month, providing a continuous hazard to all plant life. As a result, vegetation, both cultivated and native, has suffered injury through the killing of portions of the leaf surface and through retardation of growth. Increased acidity of the soil, due to the addition of sulphur dioxide to it, results in restricting the range of crops. Also, with the destruction of the native vegetation, the invaluable protective effect of the forest cover in regulating stream flow is lost, and irremediable soil erosion sets in. Furthermore, dead foliage and trees increase the fire hazard, and reforestation afterwards is impossible.

The zone of pollution of the atmosphere extends at present to Marcus, 42 miles down the Columbia River from the international boundary. The area of most severe injury to vegetation is, of course, in the vicinity of the smelter and at the lower elevations, decreasing with distance from the source and with altitude.

Because of complaints of the residents of Stevens County, Washington, the matter was turned over to the International Joint Commission of the United States and Canada for investigation. The Commission reached a unanimous agreement with regard to its recommendations, which provided among other things for the payment of $350,000 to the United States to cover injuries up to January 1, 1932. After that time the Commission believes that damage from the fumes will be reduced if not entirely eliminated through installations to reduce the sulphur content of the fumes discharged from the stacks. The recommendations of the Commission have not yet been accepted by either government.

EDITH M. FITTON

Seattle's Water Supply Question. Large and growing cities are apt to find themselves confronted with a domestic water supply problem in some form or other. Competition for drainage areas and protection for present and future needs leads not infrequently to litigation (R. M. Brown: The Water Supply of Cities in the United States, *Scientific Monthly*, Vol. 33, 1931, pp. 135–141). Cases have arisen more particularly in the densely populated parts of the humid east or in the arid or semiarid west. A unique case is presented by Seattle. In 1930 the city brought suit against a lumber company to prohibit its operations in the Cedar River watershed supplying the city (B. E. Hoffman: Seattle's Watershed Controversy, *Journ. of Forestry*, Vol. 30, 1932, pp. 558–568). The water supply drainage area embraces 91,000 acres of the Cascade Range and supports good stands of commercial timber.

The city claimed that the forest growth was an integral part of the water system and was necessary to conserve the quantity and quality of the supply. The effect of the forest cover on the quantity of water and rate of run-off was the most important issue of the case. Among data presented in evidence were Weather Bureau records of precipitation for periods before and after logging operations commenced.

For the former, 1905–1917, the average annual precipitation was 107.36; for the latter, 1918–1930, 103.7 inches. The decline, however, is in accord with the general climatic trend in the region, the most recent years being exceptionally deficient in moisture. Measurements of stream flow at the outlet of Cedar Lake showed an increase of about 20 per cent run-off in the second period, but here an admittedly unknown factor entered in—the reduction in seepage. Both sides agreed that deforestation increased the water available for run-off. Among qualitative effects pointed out was an increase of the water temperature in relation to the temperature of the atmosphere.

The interesting feature of the case is the way in which it lifts to the practical plane the old standing controversy of the relation between forests and climate, revealing in the "conflicting nature of the testimony . . . the inconclusiveness of much of our knowledge concerning the effect of forests on precipitation, run-off, air temperature, and erosion."

Easterly Winter Gales in the Columbia River Gorge. The gorge of the lower Columbia is remarkable climatically and physiographically. Lewis and Clark exploring down the river in 1805 made their way by a water-grade route through a mountain barrier "which averages four to eight thousand feet in height, with peaks within 25 miles to the northward and southward rising to eleven and twelve thousand feet." Today "the airplane finds here an easy passageway at normal flying levels through a mountain [range] which at any other point north or south would require an ascent to at least four or five thousand feet to clear the lowest passes in safety." The demands of the new mode of transportation led to the establishment of four Weather Bureau stations in the gorge—at Crown Point, Cascade Locks, Hood River, and The Dalles, respectively 24, 45, 65, and 90 miles from Portland. A first result of the intensive meteorological study thus made possible is a paper by Donald C. Cameron, "Easterly Gales in the Columbia River Gorge During the Winter of 1930–1931—Some of Their Causes and Effects" (*Monthly Weather Rev.*, Vol. 59, 1931, pp. 411–413).

As an effective example of the easterly gales of winter we may quote the record for November 21 to 30, 1930, when the wind blew from the northeast or east every hour of the 240 hours, averaging a velocity of 33.6 miles an hour. As would be expected, the cause of these gales lies principally in the higher pressure and lower temperatures of the interior behind the barrier of the Cascades. An ideal condition for the occurrence of winds of hurricane strength is "a strong high moving southward into eastern Washington and Oregon from Canada and an oceanic low-pressure area off the central Oregon coast." Perhaps the most striking effect of the strong, dry easterly winds is the marked reduction of ground fog in Portland as compared with places to the north or south. Thus from November, 1930, to February, 1931, the hours of moderate or dense fog at Portland were 229 compared with 580 at Salem, 50 miles to the south, and 409 at Seattle.

A New Theory of the Origin of the Lower Columbia River. The Columbia scarp, running on the northern side of the river for 80 miles east from the easternmost fold of the Cascade Mountains and attaining an elevation of 3000 feet, is a feature rivaling in its impressiveness scarps of the Great Rift Valley of Africa. In a paper "Columbia River Fault" (*Bull. Geol. Soc. Amer.*, Vol. 42, 1931, pp. 923–984), Edwin T. Hodge presents evidence as to its origin as a fault scarp and thence proceeds to show the influence of the fault upon the course of the Columbia River.

The original youthful Columbia River basalt surface of north-central Oregon was divided into two parts by the east-west fault. South is the *Shaniko surface* which descends in a general northerly direction. Two of the original, unintegrated parts of Columbia River developed in Maryhill trough on each side of Klondike anti-

cline (see original paper for diagrams and details of structure). The westernmost flowed through the Cascade Mountains on a structural lowland south of Mt. Hood. The outlet of the ancestral Columbia River was partly blocked and aggraded by pyroclastics, water-worked débris of late Pliocene or early Pleistocene Cascade Mountain volcanoes. This material, now called the Dalles beds, filled the lowlands and was washed eastward where it formed a great piedmont deposit on the east side of the Cascade Mountains. The aggradation, aided by the wind-borne pyroclastics and by the gravels brought from the east, moved up river. Finally, the ancestral Columbia was completely dammed by the later Cascade Mountain lava flows. This damming produced Condon Lake which rose to an elevation of about 1900 feet. Deposits were laid upon the floor of the lake and the margins were marked by shore gravels. The lake beds lie over the earlier gravels of the trough and are, in turn, overlain by a wide belt of gravels that extend from Wallula Gateway westward to The Dalles. When Condon Lake was filled and later drained, a notably braided river flowed westward across the bottom deposits. The lake beds transgress Horse Heaven Hills and so permitted the lower section of the Columbia to capture the upper Columbia and Snake rivers, diverting these streams southward.

The integrated Columbia River was supplied with a large volume of water received from the Pleistocene lakes and glaciers of the upper Columbia River basin, with abundant tools from the lake and the Dalles beds, and with a gradient from 1900 feet at the eastern margin of the Cascades (Ortley anticline) to sea level at Willamette Valley. The river was rapidly entrenched. There is abundant and positive evidence of canyon cutting since the deposition of the lake and Dalles beds. The retrogressive erosion of the new Columbia River led to the incision of highly developed meanders of the John Day and Deschutes rivers. The incised meanders occur only in the portions of these two rivers south of the lake beds, or upon the uncovered Shaniko surface. The consequent streams formed upon the surface of the Dalles beds, and flowing thence across the surface of the lake beds, developed yazoo-like entrances into the Columbia River.

During the beginning of entrenchment, icebergs carrying glacial erratics from northern Washington drifted downstream and stranded. The transportation of erratics continued until a late stage of canyon cutting. In another paper (Exceptional Morainelike Deposits in Oregon, *Bull. Geol. Soc. of America*, Vol. 42, 1931, pp. 985–1010) the author describes a moraine-like topography created in gravels and developed by iceberg jams which diverted the river from its former normal curve to an abnormal one. The blockades occurred when the river was in an initial stage of superposition on anticlinal ridges of basalt at the mouth of the John Day and immediately west of The Dalles. The young Columbia River canyon has also been partly dammed by Recent lava flows, a fact that should be considered in contemplating dam construction.

This investigation places the events of the Tertiary history of Oregon in a revised time scale. Thus an ancient stream, dating from the Miocene, becomes the lower part of the Columbia as integrated in Pleistocene time. The two ancestral parts of the present-day Columbia had their origin on a late Pliocene surface. They were integrated and superposed because of the possibilities presented in part by the lake and Dalles beds of Pleistocene age. The great mass of the lava flows of the Cascade Mountains are later than the Dalles beds and therefore probably of middle Pleistocene age. Mt. Hood and the great phalanx of towering volcanoes are of late Pleistocene age.

The Last Spanish Exploration of the Northwest Coast. Another chapter in his numerous studies on real and imaginary voyages in the exploration of western North America is given by Henry R. Wagner in "The Last Spanish Exploration of the

Northwest Coast and the Attempt to Colonize Bodega Bay" (reprinted from the *Quarterly* of the California Historical Society, Vol. 10, 1931, pp. 313–345).

The voyage of exploration in question is that of Francisco de Eliza in the brigantine *Activo* (*Activa*) and Juan Martinez y Zayas in the sloop *Mexicana* in 1793. Translations from the explorers' little-known journals (the originals are in the Archivo General in Mexico) follows an introductory commentary. The vessels, Eliza in command, set out from San Blas, Mexico, on April 30. Eliza returned with "the usual story about having been prevented by the winds and a lack of water from reaching any higher latitude than about 44°." The *Mexicana*, however, reached the Strait of Juan de Fuca according to orders and followed the coast very closely from the strait southward, making a *carta esferica* of the entire stretch to San Francisco and plans of Grey's Harbor and Tomales Bay and the mouth of the Columbia (copies of these maps are in the Library of Congress). The last named is of special interest. The expedition's instructions called for "a long and minute examination of the Columbia River," which they were to follow "until they reach its source." Arrived at the "Entrada de Ezeta," Zayas found "a great opening presenting itself . . . whose salient shoals allow of an entrance three miles wide." He crossed the bar, but fourteen miles from the "Cabo de San Roque" he ran aground in four feet of water. This misfortune and the hostile reception of the Indians, as he says, discouraged further investigation.

The emphasis laid on the survey of the Columbia River was due to the Spanish viceroy's anxiety over the maintenance of Spanish rights on the coast south of the Strait of Juan de Fuca. "Protection of the establishments of California proper furnished the motive for this northward extension which was to begin by colonizing and fortifying Bodega" (Tomales Bay), immediately north of San Francisco.

EUROPE

The Glaciers of Iceland. The existing glaciers in Iceland were mapped and described by Thorvaldur Thoroddsen during the years 1881–1898, but their physical conditions and oscillations were little considered until 1930. In this year J. Eythorsson, chief forecaster of the Meteorological Office of Iceland, visited several of the glaciers, mapped and photographed their fronts, determined their position in relation to fixed points, and measured the altitudes of the snow line as preliminary steps towards the formulation of problems for research (On the Present Position of the Glaciers in Iceland: Some Preliminary Studies and Investigations in the Summer 1930, *Vísindafélag Íslendinga* (*Soc. Sci. Islandica*), *No. 10*, Reykjavik, 1931).

The snow line was taken as the boundary between *névé* and glacier ice during the second half of the ablation period, or about the middle of August. From observations by Thoroddsen and others a table and a map of the snow line have been prepared. The firn line is lowest, or 400 meters, in the northwestern part of the island and is highest, or some 1600 meters in the east-central region, north of the Vatnajökull. Near the southern coast it mostly lies at altitudes of 900 to 1000 meters.

The weather of Iceland is very unstable, especially in winter. During autumn and winter the pressure disturbances produce strong southeasterly winds, which cause heavy rains with sleet in the high, mountainous southern half of the island. The central and northeastern parts receive much less precipitation, which may be the chief reason for the high snow line there. The southeasterly storms on the south coast are frequently followed by heavy northerly snowstorms on the northwest coast.

From the height of the snow line and the mean temperature during June–September, the temperature at the snow line during summer has been calculated and found to range from −0.7° C. in the east-central region to 4.3° C. in the northwestern part. The latter figure suggests that the snowfall, which mostly occurs during

strong wind, is much greater than has been measured. In Norway and the Alps the mean summer temperature at the snow line is in most places 2° C.

There are only scattered data on the modern oscillations of the Icelandic glaciers. Most of the glaciers visited by Eythorsson in 1930 have been receding during the last decades or the last few years, but one has been advancing.

ERNST ANTEVS

The Cartography of Iceland. Iceland appears on some of the medieval monastic maps. It figures in different forms and in various relations to other lands and islands on Italian, Spanish, and Portuguese portolan charts. In the mid-sixteenth century Breton codfishers brought to the map makers of Dieppe somewhat better information. Dr. Halldór Hermannsson devotes the first part of his study "The Cartography of Iceland" (*Islandica*, Vol. 21, 1931) to the unraveling of these early cartographic traditions and influences, but at best it is an unsubstantial, wraithlike figure of Iceland that he follows. Not until the times of Bishop Gudbrandur Thorlákkson (1542–1627) and of his great-grandson Bishop Thórdur Thorlákkson (1637–1697) does the Iceland of cartographers begin to take on flesh and blood. To these two ecclesiastical map makers Dr. Hermannsson has devoted a special monograph (Two Icelandic Cartographers, *Islandica*, Vol. 17; see *Geogr. Rev.*, Vol. 17, 1927, pp. 334–335).

Not counting the work of the Thorlákksons, the best seventeenth century maps of Iceland were made by the Dutch. Although Iceland and Denmark had had the same king since 1280, the earliest official Danish map of Iceland did not appear until 1723. Between 1730 and 1734 a Norwegian army officer, Knopf, carried out a survey under orders of the Danish government. The resulting map "for nearly a century . . . was the standard map of the country upon which all other map makers drew."

Dr. Hermannsson ranks Björn Gunnlaugsson (1788–1876) as the greatest cartographer of Iceland. While serving as a school-teacher, he spent every summer but one from 1831 until 1843 in the field. With poor equipment, little money, few instruments, and no assistant he succeeded in the "herculean task for one man" of making a survey that has proved to be "very accurate" for the inhabited regions and even for the uninhabited areas "surprisingly correct." His map (scale as finally published, 1:480,000; in 4 sheets) has remained authoritative "down to the present day and is still used by many, although now partly superseded by the latest survey."

ASIA

A Severe Earthquake in Burma. The earthquake of May 5, 1930, at Pegu, 48 miles northeast of Rangoon, was very severe, as shown by the damage done, by the fact that it was recorded by seismographs all over the world, and by the area over which it was felt (J. Coggin Brown, P. Leicester, and H. L. Chhibber: A Preliminary Note on the Pegu Earthquake of May 5th, 1930, *Records Geol. Survey of India*, Vol. 55, 1931, pp. 221–270; S. W. Visser: Determination from World Records of the Zero Time and the Epicentre of the Pegu Earthquake of May 5th, 1930, *ibid.*, pp. 271–278; P. Leicester: Note on the Long Distance Wave Speeds of the Pegu Earthquake of May 5th, 1930, *ibid.*, pp. 279–284). The shock came without warning about a quarter after eight in the evening and was immediately followed by the outbreak of fire. The area of greatest intensity was comprised in a rough oval whose longest diameter (directed about north-northwest) was 900 miles long, and whose short diameter was 500 miles, making a total area of about 350,000 square miles. This, however, is only approximate, as the left side of the oval lay in the Bay of Bengal. The highest intensity is put at IX, Rossi-Forel scale, and covered an area of about 375 square miles extending from Pegu in a narrow oval about 45 miles due south. The intensity at Rangoon is put at VII. These

estimates seem too low. The region most affected is the eastern part of the great delta of the Irrawaddy River and the confluent part of the delta of the Sittang. It is a great alluvial plain rising but little above the sea, almost level and saturated with water. Some parts of the plain are periodically inundated. The coast line has shifted many miles in the last few decades, being at times cut into by erosion and at times built out by deposition. The native houses are flimsy affairs, built mostly of bamboo.

The geology of the region is simple. The general structure lines run nearly north and south. There are a few low ridges of laterized Tertiary rocks following the same directions; they have been gently folded by east-west compression. Between them are the delta and estuarine deposits of post-Eocene time. These ridges afforded a firmer foundation than the alluvium, as shown by a less degree of damage to the buildings on them. It is probable that the region is underlain by old crystalline rocks; they are not visible in this region but appear farther north, where they are separated from the recent deposits by a great fault.

The cause of the shock is assigned to a fault in the underlying rocks due to the general uplift of the region, as shown by raised beaches on the western coast, by indications in the alluvial plain, and by the elevation of three quarters of a foot of the region near Pegu at the time of the earthquake, clearly shown by the gauge on the locks of the Tawa canal.

A number of earlier shocks are recalled, and a list of after shocks is given. It is interesting to note that the latter were more numerous north of the epicentral tract, apparently owing to the later extension of the fault movement in that direction.

Visser and Leicester discuss the time of the shock separately. Visser puts the time at 13h. 45m. 41s. G.M.T. based on the arrival times of the disturbance at many observatories. Leicester makes it about 2½ minutes later, as the sidereal clock of the Port Observatory at Rangoon stopped at 13h. 48m. 5.6s., and the Pegu Station clocks stopped about half a minute later. A more fundamental study will be necessary to remove this discrepancy.

HARRY FIELDING REID

MATHEMATICAL GEOGRAPHY

Primitive Cartography. Some primitive folk make maps for their own use. In the National Museum at Copenhagen there are specimens of relief maps carved by Greenland Eskimos out of driftwood. The Marshall Islanders construct maps showing currents and areas of rough water by tying sticks together and fastening to them shells representing the islands (Sir Henry Lyon: The Sailing Charts of the Marshall Islanders, *Geogr. Journ.*, Vol. 72, 1928, pp. 325–328). Reindeer blood has been used by the Chukchi of Siberia in coloring their maps. Other primitive people, not perhaps in the habit of drawing maps, are able to carry in their heads the details of the topography of large areas and, when asked, to sketch them on sand or snow or with pencil on paper. An Eskimo in 1909 made for R. J. Flaherty a sketch map showing the extremely intricate outlines of the hitherto unexplored Belcher Islands in Hudson Bay. Subsequent surveys showed that his delineation, except for minor errors in proportions, was accurate even in small details (*Geogr. Rev.*, Vol. 5, 1918, pp. 437 and 440). Alois Musil during his explorations in Northern Arabia relied on Bedouin guides for some of the topographic information that he incorporated on his maps covering the areas lying between his routes of march, and this information, when checked, nearly always turned out to be substantially correct. The cartographic gift, however, is by no means universal among the Bedouins, many of whom seem to be quite lacking in sense of direction (Alois Musil: The Northern Ḥeğâz, *Amer. Geogr. Soc. Oriental Explorations and Studies No. 1*, New York, 1926, p. 98).

The most comprehensive and scholarly study of primitive cartography is unfortunately not available to most Western students, as it is in Russian (B. F. Adler: Maps of Primitive Peoples, *Bull.* (*Izviestia*) *Imp. Soc. of Students of Nat. Hist., Anthropol., and Ethnog.*, Vol. 119 (*Works of the Geogr. Branch, Part II*), St. Petersburg, 1910). Adler's monograph, however, has been summarized at considerable length by H. de Hutorowicz (Maps of Primitive Peoples, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 669–679) and more briefly by Hans Findeisen (Landkarten der Naturvölker, *Der Stein der Weisen*, Vol. 4 (N. S.), 1927, pp. 31–33).

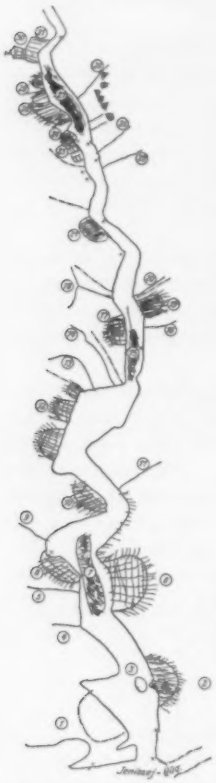

FIG. 1—Lower course of the Stony Tunguska River, Siberia, as drawn by a Yenisei tribesman.

Some maps drawn in 1927–1928 for Findeisen by members of the Yenisei or Keto tribe of Siberia are described and illustrated in a paper entitled "Landkarten der Jenissejer (Ketó)" (*Zeitschr. für Ethnologie*, 1930, pp. 215–226). In a later number of the same periodical (1931, pp. 196–201) Adler discusses and furnishes reproductions of three admirable maps of the Anadyr estuary made by the Chukchi. Figure 1 is a reproduction of one of the Yenisei tribesmen's maps. It shows about 45 miles of the course of the west-flowing Stony Tunguska River above its outlet in the Yenisei. The river is indicated by the roughly parallel lines, and its tributaries by the solid lines. Comparison with an official Russian map shows that the general course of the river is somewhat too straight but that the minor curves and tributaries are accurate. The numbers (added by Findeisen) refer to place names reported to him by the draftsman. The semicircular patches with crosshatching are bluffs of red marl (*Mergelabhänge*). This marl is used by the Yenisei people in painting their pottery. Woods are marked on some of the bluffs. The two conical symbols between Nos. 25 and 26 represent tents, and the four rectangular symbols earth huts. No. 30 is the consumer's coöperative store of the Yenisei tribe, standing on a bare rock (No. 31). The chimney, with smoke issuing from it, is suggested.

The man who drew this map was known among his fellow tribesmen as a particularly clever artist, skilled in the making of animal pictures that were not only realistic but of considerable charm. Findeisen believes that cartographic skill among the Siberians is generally associated with skill in other graphic arts. The different tribes, moreover, appear to have distinctive styles of map making. Besides being of value for the light they would shed on primitive psychology, Findeisen suggests that further comparative studies of the maps made by Siberian natives might help us determine the cultural relationships of different tribes and stocks.

PHYSICAL GEOGRAPHY

Fifth Conference on Climatic Cycles. At the annual meeting of the National Academy of Sciences at Washington, D. C., April 25–27, an afternoon session under the chairmanship of Dr. John C. Merriam, president of the Carnegie Institution, was devoted to four papers on different aspects of the broad subject of climatic variations. Dr. C. G. Abbot of the Smithsonian Institution read a paper on "Periodicities in Solar Variation" in which he reported the progress made, under his direction, in the measurement of variations in solar radiation and the periodicities that

these variations seem to show. He believes he has found the key to both short-term and long-term changes of weather and climate in the changes in intensity of solar radiation, since nearly all the periodicities of weather departures from normal are identical with those found in the sun. He concluded: "We expect to discover by a little more research whether we have real cause and effect in these relationships." His paper dealt mainly with results, although some attention was also paid to the technique of observation that has brought about a marked improvement in the accuracy of the observations. Dr. W. S. Adams summarized his observations and those of Dr. S. B. Nicholson at the Mt. Wilson Observatory on variations in the length of the sunspot cycle: "The period of any one rise from minimum to maximum may vary from 9 to 14 years, and the amplitude of the maxima may vary by 50 per cent." While definite correlations have been found between solar activity and terrestrial magnetism, the correlations between sunspots and weather changes are too uncertain to be of value for purposes of prediction. Professor A. E. Douglass of the University of Arizona concluded, on the other hand, that his studies of tree rings in the western yellow pine revealed a satisfactorily high degree of correlation between rainfall variations and tree growth, and these in turn are correlated with changes in the intensity of solar radiation. He reported on improvements in the accuracy and speed of analysis that permitted him to widen greatly the scope of the method and illustrated his paper by a series of striking "curves." Dr. Isaiah Bowman of the American Geographical Society presented criteria for the correlation of sedimentary and climatic records, illustrating his argument from the results of studies on the varved clays of New England and pointing to the results that may be expected from an intensive study of the lake-floor deposits and tree rings from adjacent slopes in the Great Basin region. Preliminary results, obtained from field studies in 1930 and 1931, illustrate the method and indicate some further probable results.

This is the fifth conference on the general subject of climatic cycles. The two first conferences were reported in the *Geographical Review* (Special Supplement, *Geogr. Rev.*, Vol. 13, No. 4, 1923, pp. 657–676; and *Geogr. Rev.*, Vol. 19, No. 2, 1929, pp. 296–306.) The third (1930) was of limited scope and discussed methods mainly. The fourth took place in December, 1931, at the Carnegie Institution and emphasized objectives in the hope that the whole discussion and the research reflected by it might be more closely focused and its bearing more clearly shown on long-range weather forecasting. It is the latter object that brought about the symposium in the Academy program where the possible forecast value of such correlated studies has become an object of special consideration. The reports of the three last conferences will be published, but the time of publication has not yet been determined.

New Light on Climatic Change. Instrumental meteorological records have not been made for a period sufficiently long to demonstrate progressive climatic changes in any direction. However, students of physical geography and botany have discovered in nature a number of phenomena that have been interpreted as indicative of climatic change. Lake and stream terraces, clay varves, shore lines and buried soils have been investigated from this point of view by geographers, and in the same way variations in the thicknesses of annual rings of trees have received the attention of botanists.

During the last few years an entirely new line of research has been opened up by the botanists. It has been discovered that in peat bogs fossil pollen deposits are well preserved and present a record of the changes of vegetation in the region during the period of development of the bog. Since bogs develop most readily in regions of imperfect drainage, where the precipitation-evaporation ratio is high, it is natural that they should be associated with glacial deposits in northeastern North America and in northwestern Europe. The beginnings of the study of pollen analysis were

made by the Swedes, G. Lagerheim, Professor of Botany at the University of Stockholm publishing the first paper on the subject in 1905. In 1927, G. Erdtman (Literature on Pollen-Statistics Published Before 1927, *Geol. Fören. (i Stockholm) Förhandl.*, March-April, 1927) published the first bibliography of all studies on pollen statistics made before that year, following it in 1930 with a second bibliography (*ibid.*, March-April, 1930) listing the works that had appeared during the years 1927–1929. That the study of pollen analysis is growing very rapidly is indicated by the fact that the first bibliography has 152 entries and the second 276.

In North America work is getting under way. I. F. Lewis and E. C. Cocke (Pollen Analysis of Dismal Swamp Peat, *Journ. Elisha Mitchell Sci. Soc.*, Vol. 45, 1929, pp. 37–58) have published a pollen analysis of peat in Dismal Swamp in Virginia, without, however, drawing any inferences as to climatic change. Väinö Auer (Peat Bogs in Southeastern Canada, *Canada Geol. Survey Memoir 162*, 1930) has published a condensed account of numerous analyses in southeastern Canada, upon which he deduces a climatic sequence similar to that of northern Europe. Paul W. Bowman (Study of a Peat Bog Near the Matamek River, Quebec, Canada, by the Method of Pollen Analysis, *Ecology*, Vol. 12, 1931, pp. 694–708) has a detailed study from Quebec but, like Lewis and Cocke, has refrained from making any climatic generalizations. In addition, a great deal of valuable work is being done under the direction of Dr. Paul B. Sears of the University of Oklahoma.

After studying samples from bogs in Michigan, Ohio, Indiana, Iowa, and Arkansas, Sears found (Postglacial Climate in Eastern North America, *Ecology*, Vol. 13, 1932, pp. 1–6) that all peat sections told the same story. Stated briefly, the climate has been growing warmer and more humid. In his study of the Mud Lake bog he finds that "the record begins with fir-spruce as it does in the Bucyrus deposit. Progressive desiccation during coniferous times is suggested again by the fact that oak-hickory-pine pollen marks the transition to deciduous deposits. Above this level there is a definite increase of beech at the expense of oak and hickory, then a prolonged reversal of this condition, with oak and hickory dominant. In the uppermost layers a second reversal is indicated with a corresponding decrease in hickory, especially."

"If any conjecture may be based on such results it is that deciduous time has had largely a somewhat continental climate, drier at any rate than the present and separated from the dry late coniferous climate by a period favorable to the growth of beech."

"Lane's studies of the McCulloch bog in Iowa strengthen our evidence for postglacial desiccation. He shows coniferous forest replaced by deciduous, then prairie twice interrupted by waves of amaranth-chenopod vegetation—essentially semi-arid." In Arkansas "the succession from an impoverished oak-hickory fossil flora of low pollen frequency through a considerable *Nyssa* stage to an oak-southern-pine fossil flora of high pollen frequency with a corresponding shift from *Stauroneis* to *Eunotia* in the diatom fossils is interpreted as indicating a recent increase in climatic humidity."

"If these inferences are sound the vegetation pattern of the north central states becomes intelligible. The patchwork of plant communities—beech-maple—mixed mesophytic—oak-hickory—prairie relicts—tundra relicts, correlated in broad outlines with topography are the inevitable expression of slowly shifting climates." Sears feels that the relation to major physiographic features must be sought, at least to some extent, in the effects of such features toward hastening or retarding the expression of climatic shifts in terms of plant communities.

The results of the tentative correlation of available data on stratigraphic distribution of fossil pollen in peat deposits of eastern North America suggest "a strong parallel with European postglacial fluctuations and indicate two major periods of desiccation, or continental climate, the second warmer than the first. The reality

of one such period would be sufficient to lend weight to Gleason's [The Vegetational History of the Middle West, *Annals Assn. of Amer. Geogrs.*, Vol. 12, 1922, pp. 39–85] conclusions as to postglacial climate, based on floristic studies, and to greatly clarify the present vegetation pattern of the Great Lakes area."

The problem of determining the rate of peat accumulation has also been studied by Professor Sears in a number of ingenious ways. He states that "there appears to be a period of maximum compression during the first 15 to 20 years, and after that a much slower compression. Comparing the measurements, such as they are, for the first 70 years with those from peat certainly between 6000 and 8000 years old, it does not appear far wrong to speak of a mean rate of peat accumulation of one inch in 20 to 30 years for the past several thousand years, in the Great Lakes area" (P. B. Sears and E. Janson: The Rate of Peat Growth in the Erie Basin, in press). The application of this conventional rate to correlated deposits in Ohio has given a chronology for postglacial climates essentially the same as that already established in Europe by De Geer and others through the study of clay varves.

C. W. THORNTHWAITE

The Annual Fluctuation of Sea Level. The level of the sea furnishes the most natural and at the same time the most satisfactory datum for geophysical purposes. This level, however, is found to be subject to fluctuations of various kinds. Quite apart from the clearly recognized fluctuations due to wave and tide, which are fluctuations of short period and can therefore be easily eliminated, sea level fluctuates from day to day, month to month, and year to year. One of the most prominent of these fluctuations is that having a period of a year. This annual fluctuation exhibits interesting features with distinctive local characteristics.

In a paper entitled "The Annual Fluctuation of the Sea-Water Stage on the Coasts of Scandinavia and Denmark" (*Geogr. Annaler*, Vol. 13, 1931, pp. 197–240) Folke Bergsten studies this annual fluctuation at several stations along the coasts of Norway, Sweden, and Denmark. Along these coasts sea level is generally low in spring and high in winter, the average difference being about three quarters of a foot. The phenomenon is a composite one. There is first the static response of the waters to the variations of atmospheric pressure; secondly, there is a dynamic effect arising from the influence of the wind. The latter is here the more important factor, and its influence on sea level depends not only on its velocity and direction near the coast but is a function of the wind resultant over large areas of the open sea.

Bergsten finds that the annual fluctuation in sea level along the coasts in question can be correlated closely with the local winds and with the atmospheric pressure conditions of the neighboring open sea. The lowest stage of sea level along these coasts generally occurs in April, when the southwesterly winds are weak as a result of the decrease in the pressure gradient between the Azores and Iceland. The highest sea-level stage occurs in November, when the southwesterly winds are strong as a result of the steepening of the Azores-Iceland pressure gradient.

H. A. MARMER

HUMAN GEOGRAPHY

Notes on Salt Production. In a recent number of the *Review* mention was made of diverse aspects of the ancient and honorable trade in salt (*Geogr. Rev.*, Vol. 21, 1931, pp. 331–332). Some additional notes based on current literature follow. Along the west coast of France the production of salt was long one of the important industries with a market both at home and abroad. While the decline that set in in the seventeenth century has continued, the coastal islands and the region north of the Loire still produce a considerable amount. Elsewhere along

this coast the growing of oysters is becoming more important. New modes of transportation, the discovery of salt deposits, and cheaper and better methods of production are in a large part responsible for the present state of the industry. Its history and techniques are told by Louis Papy in "Les marais salants de l'Ouest: Étude de géographie humaine" (*Rev. Géogr. des Pyrénées et du Sud-Ouest*, Vol. 2, 1931, pp. 121–161). Also of diminishing output are the salt mines of Taodeni, famed for the great salt caravans that go to them regularly from Timbuktu. The caravans are not so large as they were some years ago, nor do they carry back as much salt. This is due in part to the importation of salt that is cheaper than the local product and in part to the decrease in the number of camels in the region available for the caravan and to the abandonment of the commerce by the nomads, whose economic activities are centering rather to the southwest (F. Rougier: Les Salines de Taodéni, *Bull. Comité d'Études Hist. et Sci. de l'Afrique Occidentale Française*, Vol. 12, 1929, pp. 476–483. Also M. Yacouba-Dupuis: Les salines de Taoudenni, *Annales Acad. des Sci. Coloniales*, Vol. 4, 1929, pp. 213–218). The potentialities of the industry in southwest Africa are discussed by T. W. Gevers in "The Occurrences of Salt in the Swakopmund Area, South-West Africa," *Trans. Geol. Soc. of South Africa*, Vol. 34, 1931, pp. 61–80. Transportation is the major difficulty. The largest pan (Cape Cross) is situated some eighty miles by road from the port of Swakopmund, and the road is in part very sandy. The present low price of rock salt makes motor transportation practically prohibitive, and shipping by cutter to Walvis Bay is also expensive. Late reports, however, state that the Railway Administration has agreed to run a weekly motor service from Swakopmund to Cape Cross. It is hoped that the local market will be secured and an export trade developed from Walvis Bay (*African World*, April 30, 1932, p. 54).

A recent paper of the Geological Survey Department of Tanganyika Territory contains the results of a survey of five salt lakes in the Territory (Basoda, Balangda, Balangdalalu, Singida, and Eyasi) visited at the close of the dry season in 1929. Of these, Lake Balangda possesses a considerable potential value. Fuel, water, and transportation facilities are available, and conditions of evaporation ideal. Lake Eyasi also is capable of supplying enough salt to satisfy the needs of the natives and support a small European-directed industry (Douglas Orr and D. R. Grantham: Some Salt Lakes of the Northern Rift Zone, *Short Paper No. 8*, Dar Es Salaam, 1931). Climatic conditions in the Italian colonies along the Red Sea are also particularly favorable for salt production, and a substantial industry has been developed. (Alessandro Lessona: La produzione del sale nelle colonie italiane, *Riv. delle Colonie Italiane*, Vol. 5, 1931, pp. 163–174; Una grande impresa industriale in Eritrea: Le Saline di Uachiro, *ibid.*, pp. 255–260). A series of photographs with a discussion of the physiography of the Algerian "Salt Rocks" is presented by E. F. Gautier in "Album des Rochers de Sel: Contribution a l'étude du modelé triasique en Algérie" (Algiers, 1931).

The salt industry of South Australia, depending on solar evaporation of sea water and of shallow saline lakes, is of considerable importance. No beds of rock salt are known. The production from the lakes is subject to seasonal variation dependent upon the dryness of the winter season. A very dry summer, though excellent for evaporation, may result in damage to the salt from dust (South Australia Department of Mines: *Mining Review No. 51*, 1930, pp. 71–76).

The beginning of the Canadian salt industry on an extensive scale dates back to 1866, when search for oil led to its discovery in Ontario—the present center of the salt industry. The salt is obtained here by evaporation of brine. In Canada salt production has never equaled the consumption, and the biggest fishing industries are along the coasts far removed from the Ontario fields. With the opening of the Malagash rock salt deposits in Nova Scotia in 1918 the condition of the Maritime Provinces has improved somewhat, but the fishing industries of the Pacific coast

still depend upon imported salt (L. H. Cole: The Salt Industry of Canada, *Canada Dept. of Mines, Mines Branch Publ. No. 716*, Ottawa, 1930).

The main industry about Lagoa de Araruama in the state of Rio, Brazil, is the extraction of salt, but here also difficulty in transportation is one of the hindrances to development (A Industria do sal no Estado do Rio, *Bol. Servico Geol. e Mineral. No. 52*, Rio de Janeiro, 1930).

The importance, historically, of the presence of salt both in upland lakes and coastal salt pans in determining the routes followed by the Indians of Mexico in their migrations is developed by M. O. de Mendizabal in "Influencia de la sal en la distribución geográfica de los grupos indigenas de Mexico" (Museo Nacional de Arqueologia, Historia y Etnografia, Mexico, 1928. Résumé in *Proc. 23rd Internatl. Congr. of Americanists Held at New York, 1928, New York, 1930*, pp. 93–100).

EDUCATIONAL GEOGRAPHY AND METHODOLOGY

A Philosophy of Geography and Geographical Regions. Dr. J. G. Granö of Helsingfors, who in 1929 published a philosophy of geography and geographical regions (Reine Geographie: Eine methodologische Studie beleuchtet mit Beispielen aus Finnland und Estland; reviewed in *Geogr. Rev.*, Vol. 20, 1930, pp. 171–172) now presents an expansion of his earlier views with application to Finland (Die geographischen Gebiete Finnlands: Eine vergleichende Übersicht nebst methodischen Erörterungen, *Publs. Inst. Geogr. Univ. Aboensis No. 6*, 1931). In the former publication he postulates that "man's environment as a material and visible complex of phenomena constitutes the fundamental objective in geographical research." These phenomena are the constituent parts of a landscape, which may be analyzed into its elements or, conversely, built up from them.

Landscapes include recognizable divisions which are subject to classification into types and subtypes. A scientific system, according to Granö, is built upon types. However, types usually represent not actualities but ideals with which the reality may be compared in terms of its close approach or its degree of departure. Since types are derived from observation of certain recurrent elements, they often represent in some sciences only an abstraction. However, in the field of geography the individual elements themselves may prove to be indistinguishable from the type.

In delineating the regions the form complexes may be classified into certain types as follows: the earth's crust or the solid earth; the water surface; the vegetation; and the cultural phenomena. Each of these types may then be divided into subtypes. By means of a system of numerals and letters it is possible to identify in a given landscape form the different elements in this classification. For example a landscape labeled "IV 25 EA ac" means that the landscape is characterized by rolling country, in which the relief is limited to an average of ten to twenty meters (IV); the water characteristics include streams of varying widths and a skerried coast line (25); the vegetation consists of natural grasses with occasional planted areas and forest (EA); and the cultural elements reveal farm buildings strung out upon the waterways or roadways, and also a number of individual buildings fairly far removed from each other (ac).

Granö discusses the technique for the cartographical representation of landscapes and for the description of landscape photographs. He attempts to arrive at a method for a quantitative synthesis of landscape elements, fully conscious of the difficulties involved. By first plotting each of the elements in a landscape and then combining them through superposition their relative significance is somewhat easier to appreciate than through any method whereby one might attempt to weigh the elements individually.

The first attempt to set up geographical regions for Finland was made by von Hult in 1895, who recognized on the basis of his own observations twenty-four natural

landscapes or regions. While lacking scientific foundation it was, nevertheless, suggestive of the possibility of establishing regional types. The classifications of Linkola (1922) and Cajander (1927), based very largely upon the agricultural or a combination of the agricultural and natural plant realms, are carefully analyzed by Dr. Granö and given due consideration in the establishment of his own regions. These regions figured in the last edition of the Atlas of Finland (1925). They are reproduced in this volume, and the basis for their construction is explained in terms of the author's philosophy with respect to landscape formations and the ultimate objective in plotting such landscapes.

Although many geographers may be inclined to challenge Granö's categories as of insufficient significance to warrant their utilization in determining regions, nevertheless, they serve to emphasize the great complexity of the problem. Geographers who insist that the regional approach of their science is the only logical one may be committing as gross an error in their enthusiasm for this method as those who have pursued the doctrine of determinism in their efforts to prove that all man's activities are conditioned by his natural environment. We may yet come to appreciate that there are numerous kinds of natural regions as well as regions in general; that we need carefully to define the term region when applying it to a given situation, rather than to generalize in the use of the expressions "natural region" or "geographical region."

Other interesting phases of Granö's geographic classification are those which he calls the physiognomic, or the state of a landscape as one sees it at any given moment, and the physiologic, that is the landscape in process of change. The physiology of a region generally is affected more by man than by any other agent. One may recognize a "natural physiology," in which case changes are effected slowly, and a "cultural physiology," or condition of rapid not to say readily visible change.

Again, in any attempt to set up geographical regions, the origin and evolution of an area should receive consideration as a basis for intelligent interpretation of the present. From this viewpoint Granö attempts tentatively to set up a classification distinguishing three eras, (1) the era when man was not on the scene and hence exerted no cultural influence, (2) the period of agricultural activity, and (3) the period when man's building activities brought about many changes in the landscape. In addition, he separates out from man endogenous and exogenous agencies affecting the earth's surface forms, particularly as agencies of "denudation and erosion" or of "accumulation."

Granö also presents a technique of delineation for the cartographical representation of regions. In certain instances he merely utilizes census data for determining areal densities, as for example population, livestock, or cereal crop distribution. In other cases he sets up figures that are more or less arbitrary but might well be expected to find general approval. Such are "high mountain areas" identified by a relief range of over 200 meters; "mountain areas" whose relief differences range from 50 to 200 meters; and still lower elevations similarly circumscribed. Water and vegetation areas are denoted by definition in general terms, subsequently measured areally after being outlined upon the map. In all cases the resultant regions, be they of the simple type including only one element or of the complex, are expressed in terms either of the percentage of the total area of the country, or of the frequency of occurrence of the particular phenomenon within the country, or in some other ratio in accordance with the type of region the author wishes to work out.

It is Dr. Granö's aim to establish a systematic and quantitative scheme for the determination of geographical regions. To be sure he has not succeeded in attaining that mathematical precision so desirable for raising the science of geography to a level comparable with that of physics or chemistry. Nevertheless, here is a study whose principles may well be extended to other areas to shed new light upon ways and means for treating geography as a fundamental science.

EUGENE VAN CLEEF

OBITUARY

Frederick Jackson Turner. Professor Frederick Jackson Turner, historian of the American frontier, died in Pasadena, Cal., on March 14, 1932, at the age of seventy. After many years of teaching at the University of Wisconsin, Turner was called to Harvard in 1910, where he served until his retirement in 1924. Since 1927 he had held the position of Research Associate at the Henry E. Huntington Library.

In an address delivered on April 4, 1914, at a joint meeting of the Association of American Geographers and the American Geographical Society, Professor Turner said: "The frontier and the section are two of the most fundamental factors in American history. The frontier is a moving section, or rather a form of society, determined by the reactions between the wilderness and the edge of expanding settlement; the section is the outcome of the deeper-seated geographical conditions interacting with the stock which settled the region. Sections are more important than states in shaping the underlying forces of American history" (Geographical Influences in American Political History, *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 591–595, reference on p. 591). In this brief and compact form the essence of Turner's stirring contribution to geographical thought is stated. Most of his career was devoted to demonstrating the importance of the frontier. In later years his interest turned to the study of sections and sectionalism. His teaching led others to imitate him, and a school of "Westerners" came into being in the writing of the history of the United States. Indeed, ever since the appearance of his epoch-making "Significance of the Frontier in American History" nearly forty years ago, all who would interpret the larger movement of American life have been obliged to take Turner's ideas into account.

"The edge of expanding settlement" as marked by a well defined line no longer existed after about 1890. In "The Significance of the Frontier" Turner stressed the effects of the final disappearance of this line. He did not, however, fall into the error of believing that with the passing of the frontier *line* frontier conditions also vanished. In a letter dated as late as December 24, 1931, he made his position clear: "As a fundamental factor (although not the fundamental factor) in American history, the period around 1890, marked by the end of the frontier line, was a real turning point. . . . With regard to . . . regions . . . where frontier conditions still show themselves, it seems to me . . . that they are local indications of survival rather than factors in the fundamental course of American development."

Professor Turner's interpretation of sections and sectionalism was built upon a firm geographical foundation. In the address quoted above he outlined a method of analyzing sectional sentiment in politics on the basis of maps showing votes in Congress and in presidential elections. In 1916–1917, while acting as Research Associate in History at the Carnegie Institution of Washington, Professor Turner inspired the preparation of a comprehensive sequence of maps embodying these ideas. The maps are included in the forthcoming "Atlas of the Historical Geography of the United States" described elsewhere in the present number of the *Geographical Review* (specimens of them are shown on Plate II, facing p. 360).

In Professor Turner was the rare combination of historical originality with geographical insight. His death is a loss no less severe to American geography than to the study of American history.

Albert Perry Brigham. The half century of Albert Perry Brigham's life of work, following his student days, was divided between a decade in the ministry and four decades in geography. He was born in Perry, N. Y., on June 12, 1855, and in the State of New York he lived throughout his busy and distinguished life. At the time of his death on March 31, 1932, he was professor emeritus of Colgate University,

honorary consultant in geography at the Library of Congress, vice-chairman of the Division of Geology and Geography of the National Research Council, and a contributing editor of the *Geographical Review* of the American Geographical Society of New York.

The outstanding facts of Brigham's education and career are contained in the *Annals of the Association of American Geographers* for June, 1930, where seven of his colleagues presented 50 pages of appreciation, "gratefully and admiringly dedicated to Albert Perry Brigham on his seventy-fifth birthday in recognition of his inestimable services to the Association of American Geographers and to the science of geography."

From April, 1900, when he became an associate editor of the *Bulletin of the American Geographical Society*, to the occasion in October, 1930, when Brigham represented this society at the centenary of the Royal Geographical Society in London (*Geogr. Rev.*, Vol. 21, 1931, pp. 142–145), and to the end of his life, he was continuously and intimately associated with the American Geographical Society of New York. He contributed eighteen articles to the *Bulletin of the American Geographical Society* and its successor the *Geographical Review*, to say nothing of brief notes and reviews. In 1912 he was the historian of the Transcontinental Excursion of the Society.

Brigham's contributions to the science of geography ranged from physiography and glacial geology on the one hand to the relations of geography and history and the field of so-called human geography on the other. He wrote books for little children in the grades and for students in high schools, normal schools, and colleges. He wrote articles on the philosophy of education and on technical geomorphology. His style was both pleasing and forceful. His works will live.

Not the least of Brigham's contributions lay in work done for the promotion of geography. William Morris Davis initiated the Association of American Geographers, the leading geographical society in the world; but it was Brigham's long and faithful volunteer service as secretary, during the formative period, that made it live and attain this position. Through lecturing abroad, at London, Cambridge, and Oxford, at Geneva, Winnipeg, Havana, and elsewhere, Brigham made it known to the world that geography in the United States was alive and growing on sound lines.

In many ways he was not unlike the Apostle Paul. He embraced a great faith. He took missionary journeys, preaching the gospel of mature and sane geography. He wrote emphatic and attractive epistles—his books. The secret of Brigham's high success, as it seems to one who loved him, was that his philosophy of geography, exemplified in his own life and works, was essentially that of the great apostle of Christianity. He had faith in the soundness and fundamental importance of geography as he and his colleagues at home and abroad were developing it. He had hope that it would live and grow. He had charity toward all the plans and ideals of all his fellow geographers of all ages and conditions, and he loved mankind. Without this triple gift Brigham could not have been the famous teacher that he was nor the well known author of whom we are proud; nor could he have played his rôle in the development of the Association of American Geographers and of the science of geography in the United States. He had a gift of speech and a genius of phraseology, and these he developed and utilized. Many men can speak eloquently and write persuasively and attractively; yet there are few Brighams.

LAWRENCE MARTIN

Ellen Churchill Semple. The death of Miss Ellen Churchill Semple on May 8 takes America's most outstanding anthropogeographer. Miss Semple was born in Louisville, Ky., sixty-nine years ago. In 1891–1892 and in 1895 she studied at Leipzig under the illustrious anthropogeographer, Friedrich Ratzel, to whom she

pays this fine tribute in the preface to her "Influences of Geographic Environment" (1911): "In my work on this book I have only one person to thank, the great master who was my teacher and friend during his life, and after his death my inspiration."

Miss Semple's first book, "American History and Its Geographic Conditions," appeared in 1903. It attracted immediate attention, and now, at the end of thirty years, it is a constantly-used reference book for students both of geography and of American history.

Her second book, "Influences of Geographic Environment," probably will be regarded as her greatest contribution to geography. Though built on the works of Ratzel and borrowing freely from them, this book reflects Miss Semple's own philosophy, represents her painstaking research, and is couched in her distinctive and polished phraseology. This work stands as the most scholarly presentation in English of the doctrine of the influence of geographic environment.

Her last book, "The Geography of the Mediterranean Region" (reviewed in the *Geogr. Rev.*, Vol. 22, 1932, pp. 336–337) appeared in 1931, heroically completed during the weeks when death was creeping on. Its preparation "involved twenty years of research and numerous journeys to the Mediterranean for field work." This book is even more largely historical in content than her two earlier ones and represents a prodigious amount of historical research, especially in the older literature of the Mediterranean lands. The thoroughness of the documentation and the endless pains in running down authorities fill the reader with admiration. It seems likely that historians may find the book more serviceable even than the geographers. During the twenty years involved in the preparation of this work, Miss Semple has published the substance of a number of the chapters as separate papers in geographical magazines. For example, her presidential address before the Association of American Geographers in Washington, D. C., in 1921, dealt with "The Influence of Geographic Conditions upon Ancient Mediterranean Stock-raising." This appears as the leading article of Volume 12 of the *Annals* of the Association.

Besides the three books already referred to, Miss Semple has been a constant contributor to geographical periodicals. These writings are less numerous than those of some of her contemporaries; but they, like the books, always represent careful and exhaustive research and are equally characterized by a fine literary style.

Besides being a tireless research worker and writer, Miss Semple was a teacher and lecturer of wide reputation. The greater part of her teaching was done at Chicago University between 1906 and 1920 and at Clark University between 1921 and 1931. In these institutions she influenced the geographical philosophy of many of the geographers of the present generation and drew many students into the geographical field. On two occasions (1912 and 1922) she gave courses of lectures at the University of Oxford.

In 1914 she was awarded the Cullum Geographical Medal by the American Geographical Society "in recognition of her distinguished contributions to the science of anthropogeography." The award to her of the Helen Culver Gold Medal "for distinguished leadership and eminent achievement in geography" was lately announced by the Geographic Society of Chicago.

Her charming personality and keen intellect made her the center of any group of which she formed a part, and in the councils of American geographers she was one of the most highly esteemed. Her more than thirty years of industrious devotion to her chosen field have left their distinctive impress upon geography in the United States.

R. H. WHITBECK

GEOGRAPHICAL REVIEWS

Washington's Surveys and Journeys

Lawrence Martin, edit. **The George Washington Atlas:** A Collection of Eighty-five Maps, Including Twenty-eight Made by George Washington, Seven Used and Annotated by Him, Eight Made at His Direction, or for His Use, or Otherwise Associated with Him, and Forty-two New Maps Concerning His Activities in Peace and War and His Place in History. United States George Washington Bicentennial Commission, Washington, D. C., 1932. 18 x 14 inches.

It is fitting that an important memorial to Washington in this bicentennial year should take the form of an atlas. Washington was a distinguished surveyor and maker of maps and plans. "At least ninety-two of his maps and related drawings have been preserved and twenty-eight of these have been reproduced" in the atlas. Surveying expeditions, military campaigns, political and personal business made of Washington a great traveler—at least within the limits of North America (his only journey outside of the continent took him to the Barbados in 1752–1753). On the map showing his principal routes there is a tangled skein of lines between Kittery, Me., and southern Virginia, with branches reaching into northern New York, into western Pennsylvania, and down the Ohio to the mouth of the Great Kanawha and with a great loop through the Carolinas as far as Savannah. Nearly half of the atlas consists of maps showing Washington's routes or, for regions where the network of routes is too closely woven, showing places known to have been visited by him. There are also maps indicating the location of lands owned by Washington, places where he did surveying, and features named for him in the United States and other parts of the world.

Of the 92 known maps made by Washington 84 are plats of surveys either of his own lands or of lands belonging to others. These are on large scales and cover limited areas. Washington was a surveyor rather than a cartographer or geographer. About the only small-scale map (1 inch = 17 miles) is a rather crude one showing the country traversed in 1753–1754 between Cumberland, Md., and Fort Le Boeuf, near Waterford, Pa. Other maps made during the Revolution disclose fortifications and similar features of military interest.

No better man than Colonel Martin could have been selected to edit—in fact to create—the atlas. It is a scholarly piece of work, carefully and tastefully executed by one who has a thorough understanding of maps both old and new.

Atlas of the Prairie Provinces of Canada

W. B. Hurd and T. W. Grindley. **Agriculture, Climate and Population of the Prairie Provinces of Canada: A Statistical Atlas Showing Past Development and Present Conditions.** 102 pp.; 204 maps and diagrs. Dominion of Canada, Bureau of Statistics, Ottawa, 1931. 50 cents. 10¼ x 13 inches.

This publication is a worthy and welcome addition to the growing list of graphic presentations of the statistical facts of agricultural distributions and land use. It is, for the most part, based on the Canadian census of agriculture for the year 1926 and is fundamental source material for students in the economic geography of Canada. In its size, form, and manner of execution the book follows the plan of "Geography of the World's Agriculture" (U. S. Dept. of Agric., 1917). The value of this atlas for the geographer lies principally in its maps and graphs, although they are

accompanied by some 25,000 words of explanatory text. The figures comprise 3 identification maps, 19 isopleth maps (mainly climatic), 50 shaded density and distribution maps, 66 dot maps of distribution, and 66 graphs of various types. Of these maps 40 are of full-page size on a scale of about 1 : 7,600,000. In these maps of page size, and also in many of the smaller ones, the value of the distributions shown is much increased by the small size of the statistical divisions used. In the absence of fixed political divisions the organized parts of the Prairie Provinces have been divided into "Census Divisions" comparable in size with United States counties. These in turn are subdivided into "municipalities," more than 900 of which are included within the scope of the maps, a detail of subdivision sufficient to give an excellent distributive picture by whatever graphic device is employed.

The range of topics covered by the publication is so considerable and so varied as to be of service to each of the social sciences. General subdivision of the topics may be made under the following heads: elements of the natural environment; general land utilization; farm crops; livestock industries; farm income and rural economic status; farm population and rural social conditions.

Some of the sections afford maps of signal importance to the geographer. Such are the fifteen new maps of the climatic section, which present a more coherent picture of critical elements of the regional climate than any heretofore; also the tentative maps of the distribution of major soil types and the main types of farming. Other noteworthy features are: a series of maps showing the distribution of wheat acreage at critical periods since 1911; several maps showing the distribution of increase or decrease in rural phenomena as compared with the census of 1921; a wealth of graphs and statistical tables showing trends in production and a comparison of the products of the Prairie Provinces with one another and with the other provinces of Canada.

The book is obviously the work of economists and statisticians, with the aid and encouragement of members of the Pioneer Problems Committee. That the result is good need hardly be said. That it might have been bettered by a little sound geographical advice and assistance is the conviction of the reviewer. First it may be noted that, while the base maps employed are excellent and the drafting and printing are good, many of the dot maps present some unfortunate features. One of these is a tendency toward "clotting" in critical areas, a condition that results from the choice of a size of dot too large for the dot scale employed. Another is the tendency of the geographically untrained draftsman to spread his dots uniformly over the "municipality," a method that results in rectangular areas of concentration that are contradictory to the facts regarding distributional transitions known to all geographers.

From a geographer's point of view the texts leave more to be desired than the maps. In the first place they are brief to the point of inadequacy, and not always for lack of space since the pages are seldom crowded. Secondly, they are made a vehicle for general facts of quantity and value, increase or decrease, and the relative importance of one of the provinces as compared with the other two. The vast wealth of geographical coincidences evident from even a casual inspection of the maps passes almost without mention. Who is interested in comments on the relative importance of the political unit Alberta as compared with the political unit Saskatchewan when map after map shows a most remarkable strip of country extending from Edmonton to Lethbridge that fairly shouts for explanation? A score of other interesting distributive phenomena and intriguing coincidences between the patterns of various of the maps are treated inadequately or, more commonly, go unnoticed. Yet we offer sincere thanks to the producers of this volume. They have furnished much of the essential material from which someone may now develop a comprehensive picture of the agricultural geography of the Prairie Provinces.

V. C. FINCH

Rural Vermont

Rural Vermont: A Program for the Future. ix and 385 pp.; maps, diagrs. The Vermont Commission on Country Life, Burlington, 1931. $1.50. 9¼ x 6½ inches.

"More than 176 Vermont towns had significantly smaller population in 1930 than in 1850. Most of these show a continuous decline, and many have lost well over half their former population." Does this recession mean decadence or is it a healthy adjustment? To determine its causes and to formulate definite policies toward the bettering of rural life have been the aims of the Vermont Commission on Country Life organized in 1928. The commission, for which the original plan was developed by Professor H. F. Perkins of the University of Vermont, has made a comprehensive survey, carried out under the direction of Dr. H. C. Taylor, formerly of the U. S. Department of Agriculture, by some twenty committees of leading Vermonters, aided by trained investigators in special fields. "Rural Vermont" contains the reports and recommendations of the committees.

The concrete recommendations of the committees cover a very wide range of problems in the fields of agriculture, forestry, land utilization, medical service, education, rural government, citizenship, and religion. There are also studies of summer residents and tourists, rural home and community life, recreation, and the conservation of Vermont traditions and ideals. The cost of putting the recommendations into effect all at once would be prohibitive, but this is not contemplated. The Commission has tried to establish standards and to set goals many of which can be reached only after a long lapse of time. The Committee on Education, for example, points out as obstacles in the way of its program (1) the entrenchment of the town as the local political unit, (2) Vermont conservatism, and (3) town-country antagonism. These, however, are difficulties not peculiar to Vermont. It speaks well for "Vermont conservatism" that two hundred representative Vermonters can subject their state to such candid self-analysis as is revealed in "Rural Vermont" and with so little of the booster spirit creeping in.

Several of the recommendations have a geographical aspect. In Vermont, as elsewhere, institutions that efficiently met the needs of the larger rural population of a generation and more ago are proving inadequate, burdensome, and often unnecessary in this motorized age. Essentially the same suggestion is many times repeated—that institutions and agencies be reorganized into fewer units, each serving more people over wider areas and at a lower cost per person than hitherto. Small towns should be grouped "so that they might avail themselves of the advantages of a municipal manager or in some other way eliminate the crushing expense which characterizes the attempt of too few people to support the institutions which are essential to modern standards of living." The Committee on Education suggests "the voluntary formation of enlarged school districts made up of several towns or portions of towns. These units should be determined by considerations of the optimum size and of geographical, trading and social factors, and by soundly guided public opinion." Welfare districts should be marked out and welfare officers placed in charge of them who would take over much of the work now handled by the overseers of the poor in each town. "Topographical features should be the controlling factors in making up such districts." The present movement toward the union of churches in towns where several denominations work at cross purposes should be encouraged. Health districts should be organized comprising several towns. Regional library field services should be further developed under the direction of regional librarians.

We are informed that the Commission will continue in existence, striving for the adoption of as much of its program as circumstances permit, and also that many local groups are now carrying out intensive studies of their own communities.

Economic Structure of the Northwestern United States

Edwin Bates. **Commercial Survey of the Pacific Northwest.** 356 pp.; maps, diagrs., ills. *Bur. of Foreign and Domestic Commerce, Domestic Commerce Series No. 51*, Washington, 1932.

Commercial interest in our Northwest dates back to early days. "When Washington became President two ships of the American flag were in the region of Puget Sound searching for a cargo of furs for the China trade. One of these continued the voyage to Canton, exchanged furs for tea, and returned to Boston in 1790, making the first commercial voyage around the world under the American flag. On a second trip Capt. Robert Gray discovered and explored the lower part of the great river system which drains a vast area of the Pacific Northwest." . . . "In much the same way as the early explorers and traders in this region were impressed with its many special and peculiar features as compared with those of the Atlantic seaboard, so will the reader of this report find many special features in the economic background of the area, in the distribution of its population, and the general characteristics of its consumer market."

The basis of this development is found, in large degree, in the physical environment of the region, which is composed of contrasting and well defined areas. Such physical conditions as marked seasonal distribution of precipitation, moderate temperatures, proximity to tidewater, fertile soil, mountain areas, forests and fish, location at the mouth of a great river highway and at the eastern terminus of a Pacific great circle route to the Orient, have made possible one type of commercial and economic development in the western part of the area, while aridity, semi-aridity, mountains and valleys, mineral resources and grazing lands are the foundations on which other commercial and economic structures have been erected in the eastern part of the area.

A close relationship between economic and commercial activities and the physical resources of the region is revealed by the survey. Mr. Bates's fieldwork showed that the commercial region centering around Puget Sound and the mouth of the Columbia River extends into western Montana and northern and southwestern Idaho. Emphasis is laid on the outstanding importance of the Cascade Mountains as "a boundary in the market structure" of the region. From an introductory review of this and other fundamental features Mr. Bates proceeds to the first part of his study, which treats the economic background of the area, dealing with its industries, population, transportation, and trading areas. The second part contains a market analysis of each economic area.

Although this survey, like others of the series, is intended primarily for the guidance of "manufacturers and distributors," the emphasis laid on the connection between economic activities and physical environment together with the vast amount of information presented makes it no less valuable to the geographer.

Helen M. Strong

The Pacific Northwest

George F. Cotterill. **The Climax of a World Quest: The Story of Puget Sound, the Modern Mediterranean of the Pacific.** 226 pp.; maps, ills. Olympic Publishing Co., Seattle, [1928]. $2.50. 8½ x 6 inches.

George W. Fuller. **A History of the Pacific Northwest.** 383 pp.; maps, ills., index. Alfred A. Knopf, New York, 1931. $5.00. 9½ x 6½ inches.

The Pacific Northwest of America is the outpost of Occidental "outlook and opportunity," the end point of four centuries of exploration and colonization by European man. The opening chapter of Cotterill's book is a brief sketch of the more important post-Columbian voyages of discovery to America, concluding with

Hakluyt's summary. Chapter 2 presents the story of Juan de Fuca and his supposed voyage to the Northwest. Then follow chapters dealing with the activities of France, Portugal, Britain, Spain, and Russia in their quest for the Northwest Passage. Chapters 8–23 very admirably cover in considerable detail Vancouver's exploration of the Puget Sound-Georgia Strait waters and the naming of the features and points discovered. The concluding chapters deal with Vancouver's later exploration of the Inside Passage and Alaskan waters and his return to England. Thus ended the quest for a northwest water passage. But it inaugurated the development of a new northwest passage—"six doubled bands of steel, spanning America . . . meeting the mighty ocean carriers and bearing the commerce between the old and new Occident and the new and old Orient—realizing the dream of the ages—on the shores of Puget Sound—at the focal center" of the Mediterranean of the Pacific.

Fuller's book opens with an attractive résumé of the physiography and geological history of the Northwest. Chapters follow dealing with the American Indians and the exploration of the Oregon Country. Three chapters are devoted to the organization, activities, and settlements of the fur traders (the Northwest Fur Company, the Pacific Fur Company, and the Hudson's Bay Company). Missionary activity and settlement is quite adequately and interestingly portrayed. Colonization and the Indian Wars of the Northwest are dealt with in detail. The four concluding chapters are devoted to the social, political, and economic development of the region. The book is interestingly written and well printed and is a valuable source for those interested in the history and geography of the Northwest. The copious but well selected reference bibliography appended is of great value to the student.

G. T. RENNER

EARLY VOYAGES TO CANADA AND HUDSON BAY

J. B. TYRRELL, edit. **Documents Relating to the Early History of Hudson Bay.** xix and 419 pp.; maps, ills., index. (Publs. Champlain Soc., No. 18.) The Champlain Society, Toronto, 1931. 9½ x 7 inches.

H. P. BIGGAR. **A Collection of Documents Relating to Jacques Cartier and the Sieur de Roberval.** xxxvii and 577 pp.; index. (Publs. Public Archives of Canada, No. 14.) Published by authority of the Secretary of State under the direction of the Keeper of the Records, Ottawa, 1930. 10 x 6½ inches.

The desolate shores of Hudson Bay often resounded to the firing of musketry and cannon during the half-century before the Treaty of Utrecht (1713). A fierce naval encounter took place even among the ice floes of Hudson Strait. France and England were contending for control of the fur trade of the Canadian Northwest. York Factory, principal post of the Hudson's Bay Company, was captured by Iberville in 1694, only to be retaken by the English soon after. Again seized by Iberville in 1697, it remained in French hands until the whole region was definitely ceded to Great Britain at Utrecht.

Four contemporary narratives of these events are republished by Dr. Tyrrell. Three are by eyewitnesses: two Jesuit fathers—Antoine Silvy, who accompanied an expedition to York Factory in 1684–1685, and Gabriel Marest, chaplain on Iberville's expedition of 1694—and the author-soldier-nobleman Bacqueville de la Potherie, who took part in Iberville's second expedition of 1697. These narratives are reprinted in French from seventeenth century editions, with English translations, Silvy's "Journal" and La Potherie's "Letters" being translated into English for the first time. The fourth narrative, a history of Hudson Bay by an English writer, John Oldmixton, was compiled directly from original papers.

The route to the remote posts on Hudson Bay lay by sea around the northern end of Labrador. The three Frenchmen record many details of their stormy journeys

through this hazardous passage. Marest and La Potherie, each an observant traveler and gifted writer, tell us much of the lands and peoples visited. They describe the long, hard winters at York Factory and the short summers with their sudden alternations of intense heat and freezing cold brought by the north winds. Both refer to the terrible pests of black flies and mosquitoes and to the vast water-logged, sparsely timbered forest that encircled the little settlements at the rivers' mouths. Some information had filtered through to Marest of tribes far to the north, the Dogribs of the vicinity of Great Bear Lake, and La Potherie adds in this connection "one of the first printed references to the musk ox."

La Potherie was keenly interested in natural phenomena: the behavior of the tidal currents in Hudson Strait, the forming of sea ice and shore ice, the characteristics of glaciers and icebergs. The aurora borealis appealed to his poetic fancy. The primary value of his "Letters," however, lies in what they tell of men and manners. On authority not specified, he gives statistics of the fishing settlements along the Newfoundland coast. With a geographical eye he remarks that the Canadians' "mode of carrying on war [is] quite different from that practised in Europe" and that "this is due largely to the climate and the situation of the country." He appears to have shared philosophic ideas current at the time about "le bon sauvage" and writes of the Hudson Bay Indians as living "almost as people did in the Golden Age." He seems, withal, to have gathered many accurate details about their mode of life and religious beliefs, and he followed Marest in the opinion that it would be almost impossible to convert them to Christianity. On the whole both his attitude and that of the Jesuit were tolerant and understanding. The Englishman, Oldmixton, expresses a different opinion: "Let the Learned say all the fine Things that Wit, Eloquence, and Art, can inspire them with, of the Simplicity of pure Nature, the Beauty and Innocence; these Wretches are an Instance, that this Innocence is downright Stupidity, and this pretended Beauty a Deformity, which puts Man, the Lord of the Creation, on an equal Foot with the Beasts of the Forrest."

The 296 contemporary documents from the archives of Spain, France, and Italy edited by Dr. Biggar have to do not only with the voyages of Cartier and Roberval to Canada but with the earlier and later lives of the two explorers. Most interesting among them is a correspondence between Charles V and his ministers, here printed for the first time. The emperor was incensed by reports of Cartier's and Roberval's activities and apprehensive of hostile designs against the Spanish colonies farther south. His protests, however, were in vain, and two caravels that he sent out in search of Cartier in 1541 returned to Spain without accomplishing anything.

Norse Discovery in America

Hjalmar R. Holand. **The Kensington Stone: A Study in Pre-Columbian American History.** viii and 316 pp.; maps, diagrs., ills., bibliogr., index. Privately printed. Ephraim, Wis., 1932. $3.00. 8¾ x 6 inches.

In 1898 a farmer in western Minnesota in grubbing stumps on his farm near the village of Kensington, discovered a large flat stone embedded under a tree. The stone was firmly embraced by two of the largest roots, which had grown around it, thus giving evidence that it must have been in that position at least during the whole lifetime of the tree. The tree was about seventy years old. The stone had an inscription in runic characters, which were deciphered provisionally; but the numerals giving the date of 1362 were not then understood, and, as it was supposed that the inscription dated from the time of the early voyages of the Norsemen to America, that is from the eleventh century, and as it was evident that the text did not conform at all to that period, it was concluded that the inscription was a fraud.

Nine years later Mr. Holand took up the investigation. It soon became clear to

him that the inscription had been condemned largely on mistaken premises; and, after he had brought this fact to light, the stone became the object of a most searching scrutiny and much discussion (compare the note "A Rune Stone in Minnesota as a Possible Indication of a Norse Expedition in 1362," *Geogr. Rev.*, Vol. 10, 1920, p. 108). All persons reputed to have any knowledge of the finding were interviewed, and numerous affidavits were secured. Many points which at first seemed obscure were clarified. The results are given in this book, which bears witness of conscientious scholarly work carried out with the greatest patience and attention to details.

The translation of the inscription on the stone finally adopted reads:

[We are] 8 Goths [Swedes] and 22 Norwegians on [an] exploration journey from Vinland over the West [i.e. through the western regions]. We had camp by 2 skerries [i.e. by a lake wherein are two skerries] one day's journey north from this stone. We were [out] and fished one day. After we came home [we] found 10 [of our] men red with blood and dead A.V.M. [Ave Marie]. Save [us] from evil.
[We] have 10 of our party by the sea to look after our ships [or ship] 14 days' journey from this island Year 1362

The words in brackets are interpolated by Mr. Holand. The original language is in old Swedish or Norwegian from the fourteenth century.

The book presents convincing argument in favor of the genuineness of the inscription. Although there are points that are difficult to explain satisfactorily, they are not of such a nature as to justify its condemnation; and some points, at first obscure, have unexpectedly been cleared up by corroborative evidence.

The inscription speaks of the finding place as an island, although it is not now in any sense an island and is known not to have been an island when the land was first settled. It is, however, located on a small hill rising some thirty feet above marshes on both sides; and the surrounding physiographic conditions seem to show that several hundred years ago this hill was surrounded by water, which finally found an outlet through a gully in the northwest corner of the region. This explains the otherwise meaningless reference to an island and becomes a convincing argument in favor of the authenticity of the inscription.

The date, 1362, seemed at first very perplexing, but a study of the history of that time showed that it was actually most fitting, for in 1354 an expedition was ordered by King Magnus of Norway and Sweden to sail to Greenland with the object of reëstablishing the Christian religion among the Greenlanders, for there were reports that they had abandoned the true faith.

Nothing further is known about the expedition. It may have returned, although no direct evidence of that exists; and it is possible, as suggested by Mr. Holand, that it extended its voyage into Hudson Bay in search of the population of the Western Settlement of Greenland, known to have mysteriously disappeared in 1342.

The fact that both Swedes (Goths) and Norwegians are mentioned in the inscription is in good agreement with the king's letter, according to which the men for the expedition should be chosen partly from the king's retinue, who were Swedes, and partly as desired by the leader Paul Knutson, who was a Norwegian.

There were, no doubt, one or more priests in the party, which may explain the fact that the explorers were able to leave an inscription in writing and that they had a knowledge of Latin words and characters (A.V.M.).

Mr. Holand assumes that the explorers used the term "day's journey" in the same sense as the seafaring men, that is as indicating a distance of about 75 miles. This of course is possible; and, without it, it is difficult to explain that they were at a distance of only 14 "days' journey" from the ship, when actually they were about 1000 miles from the mouth of the Nelson River in Hudson Bay.

The statement that the ten men who were massacred were red with blood may well be true if the Indians had taken their scalps.

Surprising corroborative evidence is furnished by the finds of four battle-axes and a spearhead discovered in various places in the region of the Red River Valley. The axes are all quite similar to the Scandinavian battle-axe used in the fourteenth century.

It must be admitted that Mr. Holand's arguments for the authenticity of the inscription are well supported. The theory of a forgery is contradicted by statements and affidavits from which there seems no escape, and the corroborative evidence is very convincing.

WILLIAM HOVGAARD

SCIENTIFIC RESULTS OF THE FIFTH THULE EXPEDITION

KNUD RASMUSSEN. **Intellectual Culture of the Iglulik Eskimos.** 308 pp.; map, ills. *Report of the Fifth Thule Expedition 1921–24*, Vol. 7, No. 1, Copenhagen, 1929.

KNUD RASMUSSEN. **Observations on the Intellectual Culture of the Caribou Eskimos.** 116 pp.; map, ills. **Iglulik and Caribou Eskimo Texts.** 162 pp.; maps, ills. *Report of the Fifth Thule Expedition 1921–24*, Vol. 7, No. 2 and 3, Copenhagen, 1930.

KNUD RASMUSSEN. **The Netsilik Eskimos: Social Life and Spiritual Culture.** 550 pp.; maps, ills. *Report of the Fifth Thule Expedition 1921–24*, Vol. 8, No. 1–2, Copenhagen, 1931.

About 25 years ago I reviewed Knud Rasmussen's first book, "Nye Mennesker" (New People, viz. the Cape York Eskimos; an English translation, "People of the Polar North," appeared in 1908) in a Danish paper. Dr Rasmussen was then himself a new man in geographical literature, and the new people were a small group within the boundaries of Greenland, hidden away and forgotten in the farthest north. Already the plan had come to him to penetrate farther into "the dark continent" of the Eskimos. This was the purpose of the Fifth Thule Expedition, 1921–1924, during which Rasmussen, the leader, undertook the adventurous journey on dog sleds from the west coast of Hudson Bay through northern Canada to Bering Strait (compare Knud Rasmussen: The Danish Ethnographic and Geographic Expedition to Arctic America: Preliminary Report of the Fifth Thule Expedition, *Geogr. Rev.*, Vol. 15, 1925, pp. 521–562). He gave us, a couple of years after his home-coming, a splendid narrative of this journey in "From Greenland to the Pacific Ocean." The scientific results it was planned to present in a series of twelve volumes. A considerable part has already been published. Dr. Kaj Birket-Smith has given an account of the material and social culture of the reindeer Eskimos, together with a list of 500 words of their language. Dr. Therkel Mathiassen has described the archeology of the central and western Eskimos. Dr. Knud Rasmussen himself has so far contributed the three large volumes listed above. Finely produced, with abundant original illustrations including many most remarkable Eskimo maps and sketches, they cannot fail to arouse the enthusiasm of the reader.

These books, which tell about a little-known coast and the inland Eskimos between Hudson Bay and Alaska, are exceptional in that they mirror a people's soul. This congenial people called themselves *Inuit*, that is, human beings *par excellence*. We feel with him, who grew up amongst the neighbors of the north pole, thankfulness for the fate that led him from the distant corner in Disko Bay, where he was born, to the fulfillment of the dreams of his youth. Scarcely otherwise could most of this folklore, these myths, tales, and poems, this inner life of the Eskimo society have been discovered. Or is this saying too much?

There are other ethnologists who have collected myths and *ethnographica* before Dr. Knud Rasmussen and his helpers. I would mention particularly Franz Boas, Vilhjalmur Stefansson, and Diamond Jenness. But there is something in Rasmussen's

work that places it on a different plane—the happy interpretation, the deep understanding, the blend of warmer colors, and the more extended perspective. This is the Danish thread that runs through the tissue. Our ethnological and linguistic researches in Greenland, which were begun 200 years ago by Egede and others of the early missionaries (H. C. Glahn, O. Fabricius) and continued by Rink and Gustav Holm and others including H. P. Steensby, have founded a school in our own times.

It is owing to men like Rasmussen, and perhaps first and foremost to him, that the Eskimos have come into the lime light of popular interest today. True they have at times figured on the screen of the past, since the Icelandic sagas and annals spread the fame of the "Skraelings." But what or how much has been known about them? A great deal of misunderstanding has continued to circulate, with the known still limited and accidental, though exception must be made with regard to the works of the above-mentioned North American ethnologists and those of certain investigators in Alaska, for instance John Murdoch and E. W. Nelson. These scientists have made the Eskimo in Alaska and Canada their specialty and through their researches have brought many new things to light.

It is difficult to choose examples in the abundance of material which in Rasmussen's books is concerned mainly with social customs and products of the mind. The strange encircling ceremony which the author saw near the magnetic north pole among the Netsilik tribe is not easily forgotten. Just as touching is the returning son's greeting when he saw his mother again: she mounted the house platform, knelt down, and offered him her breast. The young man embraced her and kissed the place from which he as a babe had sucked the mother's milk. No folklorist has ever found a more beautiful contribution to the history of the kiss. These Eskimos were conscientious and were unwilling to break the taboo customs, for instance by giving up their holy amulets to a stranger, an accidental visitor, who so suddenly had appeared in the midst of a snowstorm. Rasmussen depicts with humor his "work in the service of science" when he wished to obtain these valuables, even to using a "pious fraud" by buying them with locks of his own hair.

It would be narrow-minded to find fault with a work that promises so well as this and contains so much that is positively new. Here and there are little stories that seem rather insignificant. But it is impossible to say what may have significance in the later history of research. How much would we not give for the slightest samples of the mental life of the earliest stone-age people or of the ancient cave dwellers in southwestern Europe!

We have in this book long texts in the primitive people's own language, with interlinear translations into English. How exactly these may be rendered can only be decided in the future when they are submitted to the test of practical application. But this is the great value of Rasmussen's works—that they are sources for further investigation.

WILLIAM THALBITZER

ANCIENT SETTLEMENT IN MEXICAN SONORA

CARL SAUER AND DONALD BRAND. **Prehistoric Settlements of Sonora, with Special Reference to Cerros de Trincheras.** Map, ills. *Univ. of California Publs. in Geogr.*, Vol. 5, No. 3, pp. 67–148. University of California Press, Berkeley, Cal., 1931.

To rather colorful speculations of the prehistory of the Mexican Sonora and to the work of archeologists based chiefly upon artifacts geographers have rather cautiously ventured their interpretation. As suggested by the title, the *cerros de trincheras*, "hills with entrenchments," are the chief objects of the investigation, and their interpretation involves the cultural adjustments of their builders to the area. The authors have spent months of thorough scientific observation in the field before

venturing opinion, and their report is not likely to be seriously challenged as to fact.

The main theme is the ability of the area to support the population that must have occupied it during the building of the *trincheras* and under climatic conditions essentially like those of the present. The Altar and Magdalena valleys, where "the areally most extensive and most numerous remains are found," support about 30,000 inhabitants, fed by the produce of the valley flats. Hundreds of people in addition are sustained by temporals in the dry basins or *bajio* floors. Indeed the Papago of today farm a country more arid than any settlement sites known to have been prehistoric.

The authors grant that the country had greater productive power in the past than at present, largely incident to widespread recent channel cutting, but attribute this to overstocking with cattle and also to excessive breaking of the land to the plow and wagon ruts with cumulative erosive effects. A lower standard of living than the present, that is a true Indian standard, would also have permitted a larger population, compensating in part for the introduction in modern times of wheat and domestic animals.

The fear motif for the building of the *trincheras* is suggested as decidedly preferable to the thesis of climatic deterioration, and the fortified hills as the most advantageous solution of the problem of defense, necessitated by the invasions of hostile tribes during the latter stages of the *trincheras* culture. The conclusion of Ellsworth Huntington that the *trincheras* were built for agricultural purposes, in support of his theory of recent climatic desiccation, is untenable in the light of the above analysis.

A reasonable explanation of a prehistoric culture, and a logical conclusion, should not be expected without a thorough investigation of the present geography, including all natural and cultural relationships. In this respect the authors have outdone the archeologists and climatologists. Hence, whoever is interested in the present geography of the region will find this the best source published. The area is roughly divided into the northeastern elevated steppe and the western lower desert. The former, having suffered least from the heading of arroyos, continues most nearly the conditions of the past. Drainage basins are treated as the geographic units, the culture centering on or about the irrigable valley flats of permanent and intermittent streams and the dry basins of the desert subject to summer flooding.

The generalized sketch showing the distribution of most important *trincheras* is inadequate as a map to accompany the study, but no good base map of Sonora has been made. A series of fine landscape photographs are a great help in the interpretation.

Artifacts, especially pottery wares, are given so much space relatively as to suggest an archeological rather than a geographical treatise. These pages reflect the authors' interest and also their recognition of the excellent archeological work of Dr. Byron Cummings of the University of Arizona and his assistants, which was the logical point of departure. In delimiting the area of the *trincheras* builders and placing them in the sequence of cultures, they have followed the established technique of the archeologists, though the method will not appeal to all geographers. The study may be considered a geographical or an archeological contribution. As either one or the other, it is the better for being both.

J. W. HOOVER

CLIMATOLOGY OF CENTRAL AMERICA

K. SAPPER. **Klimakunde von Mittelamerika.** 74 pp.; maps, diagrs., bibliogr. (Handbuch der Klimatologie, Vol. 2, Part H.) Berlin, 1932. M. 11.40.

Professor Karl Sapper, whose name has been associated (one might almost say synonymous) with the geography of Central America for forty years, has presented a vivid picture of the remarkable diversity of climates packed in the small compass

of Central America. His description is based chiefly on his own observations both instrumental and non-instrumental made during his long sojourns and extensive explorations. But he makes the picture as complete as now seems possible by using, with the extreme caution which his inspection has shown to be necessary, the records obtained under private or state auspices, many of which he was himself responsible for starting. In regions where data are not available—in part because of absolute lack of inhabitants—the climate must be surmised from what is known of the topography and exposure and the native vegetation. Much space is devoted to discussion of the material. This is not without its human interest, however, as for example, an entry in the journal of an interrupted record: "Observer shot." Revolutions have not permitted much continuity in official weather services. Many private stations have done better; and the organized networks of fruit and railroad companies have provided a wealth of local information.

Dr. Sapper's discussion of the climates begins with a brief account of the general characteristics, then the bulk of the contribution deals with the general topics, temperature, pressure and wind, relative humidity, cloudiness, precipitation, and thunderstorms—with the human relation worked in throughout. A brief summary of climate by regions follows. The influence of climate on agriculture and trade is discussed in three pages, and a comparison of Köppen's climatic regions with the known distributions of the major vegetation areas concludes the text. Then come twelve pages of compact tables and two of bibliography (58 titles).

A detailed map shows the divisions into the well known tierras caliente, templada, and fria. The tierra caliente, from 0 to 600 meters, has a mean annual temperature of about 26° to 30° C. This is the zone of bananas (under 200 m.), sugar cane, cacao, rubber, mahogany, coconuts, and corozo palms; at 300 meters coffee cultivation (under heavy shade) becomes possible. The tierra templada, 600 to 1800 meters, is divided in two: the lower, 600 to 1200 meters, is the chief coffee zone, mean temperature about 23° to 20° C.; the upper, 1200 to 1800 meters, still has much coffee (to about 1550 m.) and sugar cane (to about 1600 m.) but is subject to frost danger (northers). The mean temperature is about 20° to 17° C. The tierra fria, above 1800 meters, has freezing and frost annually. The lower division, 1800 to 3250 meters, is the chief region for wheat (it may take 310 days to mature), potatoes, and apples. In favorable spots tropical and subtropical plants still thrive. The mean temperature is about 7° to 10° C. Above 3000 meters maize and wheat fields are found only here and there. The upper division, above 3250 meters, is the high mountainous region, without cultivation but with coniferous trees and mountain meadows. It is a region of possible snowfall (above 3500 m.). The highest levels (above 4000 m. on Tajumulco and Tacaná) are treeless but still useful for cattle raising. The mean annual temperature of this division of tierra fria is below 10° C., and in the treeless heights it is under 6° C.

The usefulness of areas within the different altitude zones of temperature is largely dependent on the rainfall, which has an exceedingly diverse distribution. There are two large sources close to all land in Central America—the Atlantic and the Pacific oceans. From the Atlantic the northeast (to east-southeast) trades blow throughout the year bringing an abundance of rain to the coast and mountains exposed to these winds before ascent has dried them. In winter the trades continue across the entire isthmus and descend on the Pacific slope warm and dry. But the Pacific sends its vapor with the deflected southeast trade, here a southwest monsoon, to the Pacific slope in summer and fall; and the sun, when north of the equator sets up strong convectional thunderstorms on the coasts and mountains. Therefore, the north slopes of Central America are wet throughout the year, the west and south slopes in summer and fall, and the interior in summer. Low valleys behind lofty ranges of mountains, however, are locally very dry, under 500 millimeters. The heaviest rainfall is 6630 millimeters (Sacumum, Guatemala).

Special features of the weather include *chubascos*, heavy local squalls attending thunderstorms and rains of almost unbelievable intensity; *papagayos*, or bursts of the norther, or northeast trade, onto the Pacific coast; the great falls in temperature brought by northers to northern slopes, the floods produced by them on the mountains, and hot or cool winds on the Pacific coast; hail on the high volcanoes, enough to make them white with "snow"; and occasional hurricanes—some very sudden—as at Belize last September.

CHARLES F. BROOKS

BALKAN STUDIES

KURT KAYSER. **Westmontenegro: Eine kulturgeographische Darstellung.** 134 pp.; maps, ills., bibliogr., index. *Geogr. Abhandl. herausg. von N. Krebs*, Ser. 3, No. 4, Stuttgart, 1931.

ALFRED PHILIPPSON. **Beiträge zur Morphologie Griechenlands.** 96 pp.; maps, ills., index. *Geogr. Abhandl. herausg. von N. Krebs*, Ser. 3, No. 3, Stuttgart, 1930.

HERBERT LOUIS. **Morphologische Studien in Südwest-Bulgarien.** 119 pp.; maps, ills., bibliogr., index. *Geogr. Abhandl. herausg. von N. Krebs*, Ser. 3, No. 2, Stuttgart, 1930.

One finds ordinarily so little descriptive matter on Montenegro and such limited interpretation of its geography that Dr. Kayser's well written and serviceable monograph is particularly welcome. Many pictures, diagrams, maps, and tables add much to the interpretation.

The region described is that lying between the Tara River on the northeast and the Adriatic coast range on the southwest. Density of population is put at 54 per square mile, which seems high for so mountainous a land, or 72 per square mile if the summer pastures without permanent habitation be excluded. These extensive pastures, occupying nearly one quarter of the area, are shown on the map, Figure 4, of pastural migrations, together with indications of the direction and extent of the movements of the herds, all emphasizing the importance of pastoral economy in the country. Likewise interesting is the map of climatic production zones (Fig. 5) defined according to the length of the growing season: summer barley zone of the northern uplands (6 months); maize border zone of the northern valleys (7 months); maize zone of the karst (8 months); wine and tobacco zone of the Mediterranean, Skutari basin (10–12 months). With this and the map of natural vegetation (Fig. 2) should be compared the land utilization map (Fig. 7). Among the details of distribution there clearly stands out the broad contrast between the karst landscape of the south and west with Mediterranean climate, longer growing season, and intensive cultivation in places where water is abundant—the dolines and in the neighborhood of Lake Skutari—and the grassy uplands and wooded valleys of the north.

A novel map shows the water supply and its close relation to topography. Both men and cattle use snow water mostly even through summer in the high mountains of the northeast, while in the karstland southwest most of the water used comes from limestone springs or is retained from roofs after rains in cisterns. In many valleys both in the north and central parts springs from ground water furnish ample supply.

Dr. Philippson made his first journey to Greece over 40 years ago. Here he gives us in brief compass a work of maturity. Beginning with the Peloponnesus and its parts he carries us northward through Parnassus, East Thessaly, Olympia, and even to the region of Saloniki describing the geologic and physiographic events of the Cenozoic, tracing the faults, the uprisings, and depressions of the land areas until the present topography and distribution of land and water have been derived. He believes that the relief of the young fault mountains cannot be separated in interpretations from the stratification, and he makes clear the great significance

of the base leveling, later upvaulting and subsequent depression, in the development of the present topography. He describes the marshy conditions round Saloniki as deltaic but partly due to downsinking and agrees that the present extensive reclamation works are well advised.

Dr. Louis, well known for his work in Albania, is here concerned with parts of southwest Bulgaria. A map, scale 1 : 100,000 with contours of 100 meters, carries the topography and some symbols of land utilization for an area of 900 square miles between the Struma and Mesta rivers, with relief ranging from about 400 to 1000 feet. Outcropping ledges are common on the upper slopes. Timber occupies about a third of the area. Villages are scattered among the valleys and furnish homes for farmers and lumbermen. Two smaller large-scale maps show details of both geology and physiography.

The author spent the summers of '26, '27, and '28 in this part, working out the geomorphology with considerable care, and has given us carefully prepared descriptive matter. The first part deals with the northern or low area, and the second with the southern high mountain region embracing both the Pirin and Rhodopian Mountains and the four parts of the Rila Mountains. A summary of this description emphasizes the ice work in the mountains during the ice age and points out that Vlahinski Ezera is the highest glacier, lying 9733 feet above sea level, while ten more glaciers exist at heights ranging from 8700 feet to lofty Vlahinski.

GEORGE D. HUBBARD

THE NEW MACEDONIA

JACQUES ANCEL. **La Macédoine: Son évolution contemporaine.** 352 pp.; maps, diagrs., ills., bibliogr., index. Librairie Delagrave, Paris, 1930. 11 x 7½ inches.

Doctor Ancel's book is a description and interpretation of the geographic, ethnic, and human forces that have contributed and are contributing to solve the major problem of recolonization in Macedonia. The author has a keen sense of geographic values and makes use of them in his interpretations.

To have a region transformed in a brief period of six years from one of political hierarchy, sparse population, economic instability, and "Turkish misrule" to one of political stability, racial homogeneity, comparative economic prosperity, and progressive, peaceful outlook, is a phenomenon, unbelievable in its scope, but one we have "witnessed with our own eyes" in the recolonization and rehabilitation of Macedonia. The gigantic task of transporting and reëstablishing "on the motley steppes and swamplands" almost one and a half million exchange peoples and refugees from Asia Minor and Eastern Thrace was sponsored by the League of Nations. Although the recolonization of Jugoslavian and Bulgarian Macedonia is not yet complete, in the year 1930 the Office for the Establishment of Refugees in Greek Macedonia "dissolved, having completed its task."

The author shows how nature bestowed upon Macedonia in general a favorable geographic environment, which, however, could not be fully utilized until a time when the geographer, engineer, and health official had removed certain natural and related handicaps. Coastal and river swamplands had to be drained, inroads of the pastoral nomads stopped, ravages of the mosquito checked, the health of the native population restored by the free distribution of quinine, and a health-education campaign launched before the country could be settled to a density commensurate with the favorable geographic conditions.

The first three chapters of the twenty-five in the book are introductory, discussing physical factors relating to the question of bounds and contacts. Part I deals specifically with Jugoslavian (Serbian) Macedonia. Special consideration is given to high Macedonia, the intervening marshlands, and the Vardar Valley lowlands around Skoplje as potential areas of colonization. Then follow three chapters

describing the first and second colonizations and the hygienic campaign that preceded and accompanied the settlement of the colonists.

The most important section of the book, Part II, deals with southern or Greek Macedonia where "the steppes or swamps are completely Hellenized, irrigated or drained, and all cultivated." Here have been added 638,000 exchanged populations and refugees, mostly Greek, thus raising the racial composition to more than 90 per cent Greek and in a very large measure eliminating the racial complications existing in the past. The refugee farmers, most of whom have been settled on small holdings of four to six hectares according to the size of the family, raise subsistence crops with Turkish tobacco as a cash crop and are experiencing an unwonted degree of prosperity. Almost half of the book, ten chapters, is devoted to a description of the natural environmental conditions from the Mesta River in the east to Lake Okhrida and the Black Drin in the west, as well as the methods of acquisition and appraisal of the land and settlement of the colonists in the Greek domain.

According to the author, "the production of tobacco in the colonies of Macedonia has not only transformed the economics of the country but all of that of Greece." Increase in acreage and production of tobacco is due to the special aptitude of the new immigrants as cultivators, the winter rains prolonged through April, the transplanting season, the high temperatures, the abundant sunshine and dryness of the summer, during which the tobacco matures, and the part calcareous, part clayey soils. All these factors combine to give a small, delicate-textured, light-tasting but highly aromatic leaf. The best tobacco lands are the relatively shallow, slightly stony, potassic soils of the slopes sheltered from the cold north winds. In order to produce a superior tobacco it is desirable to have a soil that retards somewhat the expansion of the tobacco leaf. The lighter, well-drained soils are of this type. The heavy marshlands are not good tobacco soils but are excellent for subsistence crops, especially for root crops.

Part III, in four chapters, summarizes the recolonization of Bulgarian Macedonia and the establishment of Macedonians in Bulgaria.

Although the city of Saloniki is closely related to Macedonia, it is, in many respects, independent of its Macedonian connections and is treated as such in Part IV. Its location at the head of navigation on the Aegean has given it commercial connections and *entrepôt* importance. Its location with respect to the land routes rounding the Gulf of Saloniki for Greece and the south, and with routes to the west, north, and east, has given the city a freight and passenger importance reaching outside the Macedonian borders.

After the destructive fire of 1922 the rebuilding of the city was placed in the hands of an urban architect, M. Ernest Hebrárd. To preserve as many of the old customs, traditions, and historical landmarks as possible and yet reconstruct the city along modern and efficient lines has been the problem of the engineer.

The frequent use of what appear to be reliable statistical tables and the profuse use of photographs and of distributional and topographic maps make of the book an excellent regional treatise on the New Macedonia.

R. B. FROST

RUMANIAN ATLAS OF AGRICULTURE

L'Agriculture en Roumanie: Album statistique. 91 pp.; maps, diagrs. Ministère de l'Agriculture et des Domaines, Bucharest, 1929. 12½ x 17 inches.

After the World War and the general shaking up of nearly everything European, Rumania undertook an agrarian reform. It has now become history, but the atlas of the current status of agriculture could never have been issued except for the great revival of agriculture and interest therein that followed this great reform. The particular occasion for the publication of this atlas was the Fourteenth International Congress of Agriculture.

The 39 maps are on the uniform scale of 1 : 2,500,000. Each is divided into 71 departments, which are in turn grouped into 11 regions, or 7 provinces, of which Transylvania is the largest. Many crops (including tree crops), livestock, sericulture (mainly in the far west), fisheries (almost wholly in the southeast), forests, experiment stations, types of agricultural machines used, agricultural industries, and farmers' associations are represented.

A relief map, a soil map, two climatic maps, and a map of eight types of vegetation are included. Railroads, many towns, densities of population, and banks of credit are shown, bringing out interesting agricultural relations to business and commercial distributions. Clever use is made of color and symbolism. There are also 45 pages of statistics, all from the last decade. Most maps and charts are based on a short series of five years, 1923–1927, or in several cases on the year 1927 alone.

The atlas furnishes a wealth of excellent geographic material. It is apparently as carefully compiled as could be expected in a country so recently launched on a modern way of doing things.

GEORGE D. HUBBARD

AGRICULTURAL ATLASES OF SCOTLAND AND IRELAND

L. DUDLEY STAMP. **An Agricultural Atlas of Ireland.** 60 pp.; maps, diagrs. George Gill & Sons, Ltd., London, 1931. 11¾ x 9¼ inches.

H. J. WOOD. **An Agricultural Atlas of Scotland.** 64 pp.; maps, diagrs. George Gill & Sons, Ltd., London, 1931. 11¾ x 9¼ inches.

The value of the dot map as a source of material for study and a challenge to interpretation is well exemplified in these two atlases. With the earlier "Agricultural Atlas of Wales" (1921) and the "Agricultural Atlas of England and Wales" (1925) by J. Pryse Howell agricultural distributions in the British Isles are covered. In addition to the maps the atlases for Scotland and Ireland include graphs, tables, and explanatory text—the whole designed to be as graphic as possible. Among particularly arresting features one may note the map of "moorland, loch and forest" (solid black), which makes the quarter of Scotland under grass and crops (white) look small indeed; and the decline in plowed land in Ireland since the middle of last century—in the Irish Free State the area of cultivated land in 1930 is less than 40 per cent that for 1851.

The maps for Scotland are for 1927 and are based on parish statistics that are unpublished. The maps of Northern Ireland are for 1928. The Irish Free State data are for 1929; and here again access has been had to manuscript material, the statistics being published only in abstract. With small divisions and detailed analysis of localities faithful pictures of conditions have been created.

ECONOMIC GEOGRAPHY OF THE NETHERLANDS

FRIEDRICH SCHÜSSLER. **Wirtschaftsgeographie von Niederland.** 119 pp.; maps, diagrs., ills., bibliogr. (Badische Geogr. Abhandl. No. 8.) C. F. Müller, Karlsruhe i. B., 1931. RM. 4.50. 9¾ x 7¼ inches.

Like other German publications of a similar character, as for example the Stuttgarter Geographische Studien, and the Aachener Beiträge zur Heimatkunde, the Badische Geographische Abhandlungen form a series that deals mainly with the geographical problems of a section of Germany—in this case of the free state of Baden. Within this series, however, there is also room for publications of a more general interest. The first one of the type is Schüssler's book on the economic geography of the Netherlands.

While there exists an excellent study of the human geography of the Netherlands from the hand of Albert Demangeon, there is little, either in French or in English,

regarding the more purely economic geographic problems of the country. In recent years a number of good studies on the Netherlands have appeared in the German language, either on the entire country or on some particular problem, as for example the writings of J. Frost on agriculture. Schüssler's book deals with the present-day economic life in the Netherlands. In the first part (pp. 5–39) he discusses the natural and the human bases of that life. Probably in few other places in the world is it so difficult as it is in Holland to make a clean division between the natural and the cultural elements of the landscape. In fact, without the human influence, there would in many places be a seascape instead of a landscape.

The stereotyped order of discussion of surface features, natural drainage, climate, natural vegetation, and man, does not well fit the particular problems here encountered. Many of the items included in the first parts of the description really belong under the heading of "Man as the Creator of the Cultural Landscape." Are not the numerous canals one of the most striking features with which man has changed the aspect of the landscape, in the low, marshy western, as well as the higher, sandy, eastern part of the country? Even the rivers, the Rhine included, have through regulation lost entirely their original character of free wanderers of the plain, man having forced them into a semi-domestic state. In the process of creating the present cultural landscape, not the reclamation of lakes came first, as Schüssler seems to think, but the protection of the low swampy lands against rivers and sea, and their effective drainage by the building of dikes and the creation of "polders." Only after that was accomplished could man proceed to drain the lakes and, step by step, fight back the sea.

The principal part of the book (pp. 40–102) consists of a description of economic life in the Netherlands as it expresses itself in the various human activities, while the conclusion (pp. 103–116) is a discussion of the economic geographic structure. These sections contain a mass of data on agriculture, forestry, fisheries, mining, industry, and communications and will undoubtedly form a welcome body of information for all who cannot avail themselves of the original sources.

There are various minor inaccuracies in the book. Sometimes the method of treatment is a little too schematic. It is hardly advisable to separate Rotterdam from its satellite ports, with which in reality it forms one large commercial-industrial complex along Nieuwe Maas and Nieuwe Waterweg. Some of the maps are rather unsatisfactory, especially that of the agricultural regions. Many of the boundaries follow lines marking the limits of major administrative divisions, where a comparison with good physical maps in any Dutch atlas might have given many valuable clews to the probable real location of these boundaries. The principle of the dot map is applied incorrectly: different types of dots for different things within the same area clearly defeat their own purpose.

The author does not give a definite answer to the question he raises, whether the Netherlands should be called an agricultural, an industrial, or a commercial country. The second term he rejects, on the grounds that Holland has no ores, no "Grossindustrie," no great industrial concentrations. Even admitting that many of the Dutch industries have an agricultural basis, it is hardly possible to call the Netherlands an agricultural country in the light of the fact that only between 20 and 25 per cent of the employed are directly engaged in agriculture.

As Schüssler says, the main factor determining the economic life of the Netherlands is its location amidst other densely populated and highly industrialized regions to which it has easy access. Such a location may offer many advantages, although in a period of high tariffs and disguised or direct import restrictions it may to a free trade country be fraught with much danger. Indications of that are found in the lists of exports and imports for the year 1925 where, for example, stands an import of 274 million guilders from the United States, against an export to this country of only 71 millions.

WILLIAM VAN ROYEN

Travels of an Economic Botanist

David Fairchild. **Exploring for Plants.** xx and 591 pp.; ills.; index. The Macmillan Company, New York, 1930. $5.00. 9½ x 6½ inches.

David Fairchild, organizer and chief of the Division of Foreign Plant Introduction of the U. S. Department of Agriculture, is an economic botanist with geographic appreciation, a reflective type of mind, and a record of extensive travel in out-of-the-way places.

In this interesting book, which the subtitle describes as "From Notes of the Allison Vincent Armour Expeditions for the United States Department of Agriculture, 1925, 1926, and 1927," Mr. Fairchild records his observations of plants, landscapes, agriculture, men, and cultures. He also records many of his thoughts on things he saw.

The book has many passages of interest to the geographer: how, for instance, the Canary Islanders grow grapes in conical pits in black volcanic ash in a land without rain; how the Javanese keep the birds away from the rice fields; "the bamboo civilization of Java"; the effect of climate on man:

"In Buitenzorg the humidity every morning is around 98 or 99 per cent of saturation. Dr. Koch told me that one morning for some unaccountable reason it dropped to 27 per cent for a few hours and the change in spirits of everybody was amazing. . . . Those who have to spend their lives in Java tell me that they feel a craving for mountain air that is almost like the craving of hunger."

In speaking of the startlingly static quality of Moorish industry and culture he says:

". . . I think of them as an organism adapted to life in this southern latitude, a life which induces sleep in the bright middle of the day and has not anywhere seemed to encourage the development of the same kind of intellectual enjoyments as have the cool gray-sky regions of central and northern Europe. Climate plays a tremendous role in the intellectual life of mankind."

The book has 100 pages on North Africa, 60 on the Canaries and Balearics, 100 on West Africa, and 200 on Ceylon and the East Indies. It has a conversational character which helps to explain the uncommonly wide variety of subjects covered by its content. Plant information naturally dominates, but there is material of interest to the student of modern history as well as to geographers, agriculturalists, and botanists. It is excellently illustrated, and the majority of the pictures would serve as illustrations for a book on anthropogeography.

J. Russell Smith

Burma: The Basin of the Irrawaddy

Karl Stein. **Birma (Das Stromgebiet des Irawadi): Grundlagen einer Landeskunde.** Maps, diagrs., bibliogr. *Mitt. Geogr. Gesell. in München*, Vol. 24, 1931, pp. 1–101.

In this monograph Dr. Stein has attempted a general account of the physical geography of Burma with special reference to the part of the country that lies in the basin of the Irrawaddy. It is pointed out that, of existing general accounts of the geography of Burma, that in the "Géographie Universelle" occupies only five pages and that by the reviewer in the *Geographical Review* of January, 1930, is scarcely exhaustive (no mention is, however, made of the reviewer's longer account in his volume "Asia" 1929). The author clearly intends to summarize the present state of knowledge rather than to add any observations of his own. Such a work would be of great value but unfortunately in this case has been carried out with such haste or carelessness that the work is robbed of real value.

The bibliography lists 147 items and would seem to aim at completeness; but,

while anonymous notes published nearly 50 years ago are included, no notice is taken of recent researches published in such periodicals as that devoted exclusively to research in Burma—the *Journal of the Burma Research Society*—and others such as the *Bulletin of the American Institute of Petroleum Geologists, Journal of the Institution of Petroleum Technologists, Transactions of the Mining and Geological Institute of India, Proceedings of the Indian Science Congress*, and the official publications of the Province of Burma. Of the items listed in the bibliography, the majority are in English, but more than half of them are misspelt or misquoted. Here and there the titles are roughly translated into German.

A similar carelessness runs through the work, mistakes occurring on almost every page. Thus on page 38 reference is made to the work of E. L. Cleeg; on page 39 he is called G. Cleeg; in the bibliography he is listed as L. G. Gleek. Actually the author referred to is E. L. G. Clegg. Figure 2 is taken direct (without even altering the English wording) from one of the reviewer's papers but is attributed to another author. In matters of simple fact the author is equally unreliable. To cite two instances only in his generalized geological map (Fig. 7), he has simply called all the Irrawaddy and Sittang delta alluvium "Plistozän." His general map (Fig. 1) is partially illegible and lacks indication of latitude. It has a meaningless succession of black lines which correspond neither to orographic nor to tectonic axes.

L. Dudley Stamp

Italian Expeditions to High Asia

Filippo De Filippi. **The Italian Expedition to the Himalaya, Karakoram, and Eastern Turkestan** (1913–1914). xvi and 528 pp.; maps, ills., bibliogr., index. Edward Arnold & Co., London, 1932. 50s. 10 x 7½ inches.

Giotto Dainelli. **Il mio viaggio nel Tibet Occidentale.** xvi and 403 pp.; ills. A. Mondadori, Milan, 1932. 10 x 7 inches.

English readers will take pleasure in this translation of Sir Filippo De Filippi's "Storia della spedizione scientifica italiana nel Himàlaia, Caracorùm e Turchestan Cinese (1913–14)," published in 1923, and will profit by the revision that brings the record up to date in the light of more recent work, notably of Dainelli's expedition of 1930. Elsewhere in this number of the *Geographical Review* Professor Dainelli describes the most important result of his expedition—the crossing from the Siachen Glacier to the Rimu by the col that he names "Italia Pass." This exploration permitted Dainelli to elucidate a confused topographic problem, clearly demonstrated by the comparative maps of the upper basins of the Rimu and Teram Shehr (Tarim Sher) glaciers (p. 401).

To the volume there has also been added a synopsis of scientific results. They have already been discussed in the *Geographical Review* (Vol. 17, 1927, pp. 138–142; Vol. 20, 1930, pp. 525–527). One cannot, however, pass over this edition of the narrative without commenting again on its charm of style and effectiveness of presentation. Here is the Rimu Glacier: "Besides us lay the glacier, all broken into shining blocks as white as cream, lying in great transversal waves. Its appearance is almost exactly that of the Seward glacier in Alaska; they both flow in valleys so wide and open as to dwarf the ranges that close them in. On the other hand, the Rimu is very different from the other great glaciers of the Karakoram—the Hispar, Biafo, Baltoro—which are cyclopean corridors between great precipitous walls thousands of feet high, and are entirely covered, at least in their lower course, by the black stony layer of the diffuse moraines. The Rimu is quite open to the light, which it reflects in the spotless purity of its séracs; and though much smaller in size than the other glaciers, it gives the impression of being much vaster."

Professor Dainelli's book is a flowing popular narrative of his expedition of 1930

in the form of chapters written while the author was in the field. Besides telling in detail of his journeys on the great glaciers, the author throws many revealing side lights on life and nature in Kashmir, Ladakh, and the high Himalayan valleys. The volume is fully illustrated with splendid photographs but lacks map or index. A more condensed narrative of the Alpine part of the expedition, with a map, will be found in the *Geographical Journal*, Vol. 79, 1932, pp. 257–274.

The South Sandwich Islands

Stanley Kemp and A. L. Nelson. **The South Sandwich Islands.** With a Report on Rock Specimens by G. W. Tyrrell. Maps, diagrs., ills. (Discovery Reports, Vol. 3, pp. 133–198, Plates 11–31.) Cambridge University Press, 1931. 18s. 12½ x 9½ inches.

The Royal Research Ship *Discovery II*, engaged on the study of the whaling grounds of South Georgia, had occasion to visit the South Sandwich Islands towards the end of February, 1930. Twenty days were spent in the examination of this often inaccessible island group, an exceptionally favorable opportunity for survey and investigation having presented itself owing to an unusually complete southward recession of the pack ice. The results of the work then performed are incorporated in this valuable quarto monograph, finely printed and magnificently illustrated, written jointly by Dr. Stanley Kemp, the scientific leader, and Lieutenant A. L. Nelson, who was responsible for fixing astronomical points and for the general mapping and charting of the islands. Other members of the staff made sketches, photographs, and notes of the topographical features; but the lack of an expert geologist on the expedition unfortunately limited the scope of observation on the fine exposures of volcanic rocks which were seen at fairly close quarters from the ship. Studies of the hydrology and fauna of the surrounding seas were also carried out. As landings were everywhere difficult and dangerous on account of the steep coasts and incessant swell, only one, on Thule Island, was successful out of five attempted landings. Geological specimens are therefore available only from Thule Island, but their petrological examination by the writer has nevertheless yielded important conclusions on the geology and tectonics of this island arc.

The most interesting results of the survey are: (1) the confirmation of Cook's statement—recently denied—that there are two islands in the Candlemas group; (2) the demonstration of the essential accuracy of the positions of the islands laid down more than a century ago by Cook and, later, Bellingshausen; (3) the confirmation of present volcanic activity in the group; (4) the discovery of a deep enclosed basin, formerly a crater, between Cook and Thule islands; and (5) the tectonic implications of the new petrographical data.

The memoir begins with a succinct history of the discovery and exploration of the islands which is enriched by quotations from the very scarce book by Bellingshausen. The South Sandwich Islands were discovered by Captain Cook in 1775 during his second circumnavigation of the globe. In 1819 von Bellingshausen of the Russian Navy discovered the northernmost islands of the South Sandwich arc. He noted the volcanic vapors rising from Zavodovski and made a landing on the island, finding warm ground in places. In 1830 Zavodovski was again landed upon by Captain James Brown, who also noted the volcanic phenomena and reported that Visokoi was a "burning mountain with smoke in many places." From 1830 until 1908, when Captain C. A. Larsen, the pioneer of modern Antarctic whaling, examined the group hoping to find a site for a whaling station, there are no records of visits to the South Sandwich Islands. Since 1908 numerous visits have been made by whalers and expeditions, and all records speak of volcanic activity on certain islands, especially Zavodovski. A general account of the group is given and then full accounts, with sketches, maps, etc. of the individual islands.

The South Sandwich Islands lie on the great loop of the "Southern Antilles," the tectonic line postulated by E. Suess running from Staten Island through the Burdwood Bank, Shag Rocks, South Georgia, and recurving back to the west through the South Sandwich Islands and the South Orkneys to the South Shetlands and Graham Land. Suess asserted that this was a great eastwardly-directed loop of Andean folding connecting Patagonia with Graham Land. The echo soundings taken by the *Discovery* Expedition show conclusively that most of the submerged portions of the loop can be traced in the relief of the ocean floor. The alternative view put forward by Professor J. W. Gregory and others is that South Georgia is a fragment of an ancient South Atlantic land, perhaps the southwestern corner of the Flabellites Land of Schwarz, and that Suess's loop, if existent at all, is much shorter than he stated or runs in a different direction. The petrological examination of the lavas collected on Thule Island showed that they are dacites and andesites of typical Andean and circum-Pacific character. They thus afford support to Suess's view of the tectonics of the South Atlantic region.

G. W. TYRRELL

UNUSUAL ESKER FORMATION

VÄINÖ TANNER. **The Problems of an Esker: Kõllaž' Jokk' Gaecce in Petsamo, Lapland.** 32 pp.; map, ill. *Fennia*, Vol. 50, No. 38, 1928.

VÄINÖ TANNER. **The Problems of the Eskers: II. The Väčer Esker, Inari, Lapland.** 7 pp.; map, diagrs., ills. Reprint from *Comptes Rendus de la Société géologique de Finlande*, No. 3, 1930.

Two cases of an unusual mode of esker formation in Finnish Lapland are described in these papers. In the former case the esker trends in a general westerly direction. It is largely a continuous, well defined, sharp ridge somewhat steeper on the north than on the south side. The surface material is fine sand with small pebbles except for cobbly material in a few places. It crosses low summits and hillocks on the floor of the lake that once occupied the depression traversed by it.

The land ice here advanced in the direction N. 25°–30° E. During the waning of the ice its lobes first adjusted their flow to the direction of the deep valleys and later stagnated. The edges of the ice lobes seem to have lacked crevasses. The esker was formed on the ice that lay in a basin occupied later on by a lakelet that discharged through three successively lower outlets near the point occupied by the eastern end of the esker. The elevation of this end corresponds roughly with the elevation of the surface of the lakelet that formed between the land and the blockading ice. Strangely enough the esker declines in elevation westward, and its western end stands 115 feet below the old lake level.

The increasing depth of occurrence of the esker below what was the level of the now extinct glacial-marginal lake makes it difficult to conceive of its deposition *beneath* the ice, since the subglacial stream that originated it could hardly have had sufficient force to transport the constituent material uphill against the counter-pressure of the lake water. Moreover, it is not clear why a subglacial stream should flow over minor summits and hillocks of the lake floor and finally escape through high passes. Dr. Tanner concludes that the esker was formed in a channel on the surface of the ice. The position of the esker near the center of the valley makes it necessary to assume that the ice body was lower in the center than on the sides, as is locally the case in Greenland and the Antarctic. While modern ice sheets have little surface débris, the marginal parts of the Pleistocene ice sheets, in Tanner's belief, had a thick coating of waste, which in the present case furnished the supraglacial river with material. The absence of tributaries is believed to be due to slumping and redisposition during the later melting of the ice bed and the lowering of the esker to the ground. The absence of fine material would seem to be due to erosion during

the lowering process, the coarse gravel sections probably being parts of the core of the esker. The esker seems to have formed in a steeply sloping canyon cut in the ice above the level of the marginal lake. Retarded ablation beneath the esker would permit bordering streams to cut down the marginal ice on either side and carry away the finest material instead of depositing it upon the top of the esker in the customary way.

The mode and rate of disappearance of the stagnant ice body in the valley are registered in pronounced marginal stream terraces, formed on the one side upon the confining hill slopes, and so preserved, and on the other side upon the shrinking ice where they disappeared. Normally the hillside terraces measure 60 to 100 or more feet in width, are bordered on the upper side by a bluff a foot and a half to more than 10 feet in height, and have a longitudinal gradient of 2 to 4 per cent. Erosion of the terrace surfaces has deprived them of their fine material. The interval between successive terraces may give a measure of the shrinking of the ice body during a single summer. If this be so, the ice margin melted back on an average 65 to 100 feet laterally and was lowered vertically 6 or 7 feet a year.

The second case is that of an esker ridge of coarse gravel formed on the summit of the highest hill in the region in Inari, northern Finland. The esker rises abruptly from an undulating field of sandy outwash gravel which is enclosed on all sides by naked bed rock. The top of the esker ridge is traversed by old stream beds. The flanks of the esker consist of boulders up to a ton in weight. The esker seems to have been deposited by a supraglacial or englacial river. Later its top was eroded by a glacier river. During the melting down of the ice the flanks of the esker were eroded, and still later the underlying hill was largely rinsed by rushing meltwater leaving only large boulders.

Other esker ridges, forming part of the same esker system, occur on steep hillsides and also appear to have had a supraglacial or englacial origin, as the marginal belt of the ice sheet became stagnant in the hilly region.

ERNST ANTEVS

EARLY MAN IN EAST AFRICA

L. S. B. LEAKEY. **The Stone Age Cultures of Kenya Colony.** xiii and 288 pp.; map, diagrs., ills., index. University Press, Cambridge, 1931. $9.00. 10 x 7½ inches.

An ancient saying is that Africa always yields something new, and in the last few years there has been a stream of new knowledge from Africa concerning the early history of mankind. One of the most telling of these contributions has been that of Dr. Leakey from Kenya, a part of which is given in this book, while other parts are to follow in later volumes; and there is already important supplementary information from him in notes and short articles in various journals. In fact, it is difficult to keep up to date with the rapid growth of knowledge.

Around Lake Nakuru in the Kenya portion of the Rift Valley system there are lacustrine deposits giving indications that at various periods in the past the lake stood 145±, 375±, 510±, 300±, 700± feet above its present level, the figures referring to levels in order of date from youngest to oldest as judged by the human implements found. Between the 145 and the 375 stage, as well as between the 375 and the 510, there were periods of aridity, during the earlier of which, that is between the 510 and the 375 stage, lakes may even have entirely disappeared. All these deposits yielded implements of the upper paleolithic or later cultures; none show evidence of great subsequent dislocations, though some variation in altitude is traceable and suggests a certain amount of tilted uplift. There are older lacustrine deposits with implements of the lower paleolithic cultures that show marked faulting: and corresponding beds at Oldoway in Tanganyika have not only human implements

of lower paleolithic date, but, according to a note by Professor Beck, Dr. Leakey, and Mr. Hopwood, they contain fossil mammals formerly thought to have become extinct after the Miocene period, and, what is still more important, the Oldoway skeleton of *Homo sapiens*. This, the observers feel certain, was not a subsequent burial that was intruded into these layers.

We thus have the probability that there was a great lake in the Kenya Rift Valley region in a period when the lower paleolithic cultures existed there and that there was afterwards heavy faulting, including some of the greater faultings of the Rift system. The observers further believe that, since that faulting, the lake system has grown and diminished time after time but without great dislocations. Some who read these results have wondered whether the rise and disappearance of the lakes may not be associated with dislocations farther north or south, but at present there is no evidence. Leakey is convinced that we have here evidence of climatic changes, the more so as, in harmony with Nilsson (see below), he equates his periods of higher levels of lakes with those of greater extensions of the glaciers on the mounts Kenya, Kilimanjaro, and Elgon. In Uganda Wayland has worked out a sequence of wetter and drier periods in close agreement with that found by Leakey in Kenya; and it seems to be increasingly probable that these alternations have a close relation with alternations of climate worked out by the Misses Caton-Thompson and Gardiner west of the Nile in the Egyptian oases. On this basis and other grounds Leakey advances the hypothesis that African wet periods correspond with the glacial maxima of Europe. The period which he calls Kamasian, before the great dislocations, is equated with the earlier ice maxima of Europe, the Gunz-Mindel series; and he suggests that the lower paleolithic cultures evolving in some parts of Africa or southwest Asia during a wet phase spread both to Kenya and southward beyond it and also to southwest Europe, to the latter probably as these ice maxima passed away.

The later rises of the lakes he ascribes to pluvial periods that would correspond with the European ice maxima of the Riss and Würm, with the proviso that the later pluvial periods are probably well posterior to these main phases of the Ice Age. Needless to say these correlations are very tentative, as there is not yet enough agreement in Europe itself concerning ice phases there. It is, however, noteworthy that opinion has recently trended towards the idea of an older ice age and a younger one, each having doubtless been highly complex in the matter of phases.

The implements obtained in Kenya are wonderfully parallel on the whole with those of northern Africa and Europe. From the Kamasian one gets Chellian and Acheulian implements of lava and obsidian, the latter material occurring in masses at Mt. Eburru. The period of the 700, 300, and 510 foot levels is called by Leakey the Gamblian, and the lake levels suggest a double maximum with partial drought between. The whole of this sequence may be correlated with the Riss-Würm or Riss-Würm-Bühl series of moraines in Europe if the notion of a correspondence is established. During this period in Kenya the Aurignacian culture occupied the caves near the lake, but the Mousterian culture occurs in many places in the open. It is interesting that the two have been found contemporary in Rhodesia and that they are mixed in South Africa. This all suggests that old views as to the extinction of Mousterian men may need revision, but we should probably beware of the idea that all Mousterian men were of the Neanderthal race. Both Mousterian and Aurignacian cultures in Kenya are well developed, and the latter used almost entirely obsidian. Leakey has been able to distinguish phases and to work out detailed comparisons with Europe. The Mousterian culture goes on into a late phase with very fine workmanship analogous with the Still Bay cultures of South Africa and even in some ways with the Solutrian culture of parts of Europe. The place of origin of the Mousterian culture is the subject of guesses at the present time, and Leakey does not attempt to contribute here. He and others think the Aurignacian, or

Early Capsian as it would be called in northern Africa, spread from Africa and perhaps southwest Asia to Europe. There occurs in the Kenya Aurignacian what cannot but be called pottery, though some suggest that the pieces found are parts of the clay lining of a grass basket that got burnt. The network pattern certainly suggests a grass basket, but it seems we are here at any rate not far from the origin of pottery in time.

After a very arid phase of climate the level of water rose to 375± feet above the present lake surface, and what seems to be a modified continuation of the Aurignacian culture flourished. This period is called by Leakey the Makalian and its culture the Elmenteitan, and in this there are definite pots. As the lake diminished it was followed by the Kenya Wilton culture, related to the Tardenoisian of Europe. None of these early cultures in Kenya have yielded any indications of agriculture, and the old idea of the association of cultivation with the invention of pottery is subject to revision. After another phase of aridity there was a rise of lake levels to 175± feet above the present surface; and the cultures associated with this Nakuran period have yielded stone bowls, mortars, and grinding stones as well as polished axes.

The above statements are made the more interesting still by the fact that skeletons have been obtained from the Aurignacian and Elmenteitan cultures, and these are of very tall, extremely long-headed specimens of *Homo sapiens*, who show a good deal of prognathism in some cases but have very narrow noses and are very different from most types of men found in Africa today. The more the study of early *Homo sapiens* advances, the more important does the extremely long head seem to become; and in various forms it is still characteristic nowadays of groups of people in remote corners of the earth, of Broom's Korana in South Africa, of the aboriginal Australians, of the Veddah of Ceylon, of the Eskimo of Greenland, and of various groups on the American continent as well as of a few people in remote spots in Europe. It occurs in large numbers in northern Africa and southwestern Asia, a region which, it is increasingly probable, was important in the early story of *Homo sapiens*.

It will thus be seen that the work in Kenya has bearings on most of the problems of the early story of our race. The book is wonderfully illustrated; and, whether its brave hypotheses need modification in the future or not, it is most stimulating and full of new facts.

H. J. FLEURE

ERIK NILSSON. **Quaternary Glaciations and Pluvial Lakes in British East Africa.** *Geografiska Annaler*, Vol. 14, 1932, pp. 249–349.

This paper deals with the Pleistocene glaciations on Mt. Elgon, Mt. Kenya, Ruwenzori, and Kilimanjaro and with Pleistocene lakes in basins near Mt. Kenya. It is based on field studies in 1927–1928, carried out partly in collaboration with Dr. L. S. B. Leakey. On the summit of Mt. Elgon, which was mapped on the scale 1:50,000, there were found cirques, large moraines, and other evidences of extensive ancient glaciers.

Stadial moraines of the Pleistocene glaciers on the mountains mentioned present so great a resemblance in location and size that it seems certain that the deglaciations were parallel events and that the climaxes of the glaciations were contemporaneous. The periods of ice retreat and of halt correspond closely with periods of sinking and halt of lake levels recorded by sediments and abandoned beaches. The stages of glaciers and of lake levels are correlated with each other and with glacial stages in the Alps. The oldest moraines and lakes, representing the Great Pluvial epoch, are, after Leakey, correlated with the Mindel or the second glacial epoch in the Alps. The last glacial-pluvial epoch in East Africa, which consists of several cold-wet and warm-dry stages, is correlated with the Riss glaciation, the last interglacial epoch, the last or Würm glaciation, and late-glacial stages in the Alps.

If we are to accept the detailed correlation presented with the late-glacial stages in the Alps, we certainly cannot overlook the great discrepancy between the rather insignificant mid-Gamblian pause in Africa and the Riss-Würm, or Sangamon, interglacial epoch in Europe and North America which appears to have been long and as pronounced as the present postglacial age. If the mid-Gamblian pause was actually only a pause, the correlation may be incorrect. Then the entire last pluvial epoch probably corresponded to the last glaciation of Europe and North America. If so, the correlations of the glacier and lake stages in Africa and in the Alps have to be modified. Such correlations may be justified as long as they are understood to be only suggestions. Definite correlation postulates evidence that the connected stages were due to universal or widespread changes in temperature, not to local fluctuations in precipitation.

ERNST ANTEVS

THE PASTORAL INDUSTRY IN THE DRY REGIONS OF THE WORLD

RAINER SCHICKELE. **Die Weidewirtschaft in den Trockengebieten der Erde.** ix and 151 pp. (Probleme der Weltwirtschaft 53.) Gustav Fischer, Jena, 1931. RM. 7.50. 9¼ x 6½ inches.

The western European or American stands now so far removed from the nomad that he fails to realize the significance of the nomadic life in man's early development. When we recall that with one single exception the animals domesticated by man for utility purposes rather than as pets or companions are grass eaters and browsers, the importance of the grasslands and deserts in the history of man's industrial development may be realized. Even the western man's religion touches the earth in a nomadic environment only. This close relationship of his early stages of development to the grasslands of the world is still further shown by the fact that his most important domesticated plants, his grain crops, are grasses.

Schickele's book, one of a very few dealing with this subject, reminds industrial denatured man of the persistence, over a large part of the earth's surface, of an ancient almost forgotten industry. Within short compass the author covers the essential features of the industry throughout the world, bringing out its manifold phases that express the results of an adjustment to differences of environment. Of necessity, however, opportunity for discussion is limited: most of the space is taken up with description. The book contains nothing new either in fact or interpretation of relationships. It seems to have been compiled from the literature, little if any evidence of personal experience being shown; yet the author has performed a useful service in bringing the material together into a single body.

Köppen's definition of dry zones and his differentiation of these into steppes and deserts is accepted. Notwithstanding the fact that the author distinguishes the two, his descriptions fail to maintain the distinction consistently. The word steppe is used somewhat indiscriminately for both grassland and desert; and, were it not for the fact that the context shows which is being described, in most cases at least much confusion might result.

The industry is divided into (1) subsistence industry and (2) commercial industry, the industry on the savana lands of parts of Africa, which may be described as sacrificial and social, being included with the former. This subdivision on character is equivalent to one on distribution also, since the former is confined to the steppes and deserts of the Old World, the latter to those of the New, including Australia. In the former the animal is kept primarily for milk, the basis of the nomad's food, and to a less extent for transport and other products than milk, mainly wool and hides. Meat for food is of very little importance. The production of commodities for sale is an incidental matter; and when they are sold or exchanged the proceeds are expended for personal adornment and a few other luxuries, not for reinvestment

in the industry or for living expenses. This, the subsistence phase of the industry is wholly a *natural* industry unmodified by amelioration of the environment. Nature controls, and man must adjust his life to raw nature, the fullest expression of this being the necessity for continual movement.

This rigid unvarying demand for adjustment and the ineffectiveness of human initiative have made nomadic man ultraconservative, fatalistic, unadaptable to such an extent that when the steppes, as during the last half century, are invaded by agricultural man the nomad does not adjust himself but dies out or retires. This, however, is not entirely true of the North African nomad and those on the borders of the Kirghiz steppes. The contact of the nomad with civilization is given some discussion in the book.

The kinds of animals raised are in general dictated by nature through the kinds of forage available and the scarcity or abundance of water. In general in the whole industry they consist of 60 to 80 per cent sheep, 10 to 30 per cent goats, 10 to 25 per cent horses, 4 to 10 per cent camels, and 2 to 10 per cent cattle. This shows, in the very small percentage of grazing and the large percentage of browsing animals, the location of the industry in deserts rather than in grasslands. In Mongolia, however, as well as in the Kirghiz steppes where a larger proportion of grassland to desert is present than elsewhere, the percentage of cattle and yaks is 14 and that of camels is low; while in Arabia and the Sahara camels are much more important and sheep and cattle are throughout large areas practically unknown.

In contrast in the New World we have the commercial phase of the industry with its attention placed almost exclusively on sheep and cattle, based on wool and meat production rather than milk, with its control of labor costs by fencing, of forage supply by limiting the number of animals, and the provision of watering places distributed uniformly over the area available, the provision of supplementary feed by curing hay or purchase of concentrates, the provision of marketing facilities, the breeding of efficient types of animals—in short, the establishment of the industry on a basis of the control of nature by expenditure of capital.

The control of surplus population in the subsistence phase of the industry, a problem not encountered in the commercial phase, is not touched on by Schickele.

C. F. MARBUT

INTERNATIONAL RIVERS

HERBERT ARTHUR SMITH. **The Economic Uses of International Rivers.** ix and 224 pp.; maps, index. P. S. King & Son, Ltd., London, 1931. 10s. 6d. 8¾ x 5¾ inches.

As population increases, the growing demand for water for irrigation, power, and domestic purposes has given rise to many controversies, national and international. The situations are so new and the developments have been so rapid that precedents have not been established on which the rights of the states may be based. This book is a pioneer attempt to collect, as a contribution to international law, the many cases of controversy over water rights now in process of solution. To a degree the geographer is not interested in the legal aspects of waterways and water rights; but it has been necessary for the author to use the case method in order to verify his conclusions, and consequently many examples of controversial problems dealing with the utilization of water are here presented. In fact the author fears lest his readers primarily interested in the law will think that the book is too much devoted to the analysis of the economic and geographic phases of the problems.

The fourteen water controversies discussed are: The Meuse and Its Canals, The Zwillikon Dam Case (between the Swiss cantons of Aargau and Zurich), The Rio Grande Irrigation Problem, The Chicago Diversion, The "Donauversinkung" (concerning the upper Danube), The Pollution of the Missouri, The Arkansas Irrigation

Controversy, The Development of the Murray River, The Rio Mauri Dispute (between Bolivia and Chile), The Apportionment of the Nile, The Diversion of the Laramie, The Boulder Dam Project, The St. Lawrence Waterway Project, and the Boston Waterworks Diversion.

It is a question just how far similarities are evident in these controversies, or whether or not each case is an individual one to be settled according to its peculiar circumstances. If the latter is true the use of precedent must in a measure be foregone. In some cases in the examples used, a judgment has been rendered on purely supposititious conclusions not supported by the facts that are later discovered. This is particularly true of the Chicago Diversion Case (see Mark Jefferson: Variation in Lake Huron Levels and the Chicago Drainage Canal, *Geogr. Rev.*, Vol. 20, 1930, pp. 133–137), and to a lesser degree it is evident in other cases, as the Rio Mauri Dispute. Some of the problems seem likely now to be settled on the basis of state rights, but it should be remembered that in the last analysis water is a necessity of peoples not of territories, and boundary lines based on parallels and meridians or any other arbitrary standard cannot offset those based on density of population.

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University of California, Berkeley, Cal.
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To the Editor:

It happens that the last two issues of the *Geographical Review* brought reviews of three unusually significant regional geographies and that these reviews illustrate how uncertain may be the fate of an author at the hands of his critic.

Griffith Taylor very evidently enjoyed the feast of facts and ideas spread before him by De Martonne's "Europe Centrale," citing them in number and with gusto (*Geogr. Rev.*, Vol. 21, 1931, pp. 688–690). In particular the reviewer commends the author for the adequacy of the morphologic statement, saying: "The reviewer has long felt that the geography of the future must be written by scientists who not only thoroughly understand the geology and morphology of a country but are willing to devote considerable space in their books to this aspect of the subject."

That Früh, who has tramped Alps and their foreland through a lifetime of devoted study, should at the last be presenting his long-awaited synthesis of the origin of the Swiss scene (Geographie der Schweiz), moves his reviewers not at all (review by Roderick Peattie and Eugene Van Cleef, *Geogr. Rev.*, Vol. 22, 1932, pp. 175–176). They pass over the whole matter of land forms with "the question as to the extent to which geology, or, in general, the origin of land forms, may (!) be incorporated in a geographic treatise." As to the content of the volume, three climatologic observations find brief notice in the review.

Gradmann's "Süddeutschland," a beautifully symmetrical study full of mellow wisdom and incisive observation, fares ill (review by Eugene Van Cleef, *Geogr. Rev.*, Vol. 31, 1931, pp. 691–692). Not a single one of the many thoughtful syntheses, original conclusions, or significant queries with which this monograph is packed gets a word from the reviewer, who, proceeding from the position that land forms are the business of the geologist, complains of the lack of attention directed "to the life responses to the physical conditions of the regions." What Gradmann does say about man, as for instance about urban centers, "takes on an almost encyclopedic character with a minimum of geographic interpretation." I wish to submit that the review is unfair in giving the impression that the study is primarily physical

and for the rest largely encyclopedic. The first volume contains 20 pages on land forms out of a total of 215, and 141 are specifically and expressly devoted to human geography! Even a "human geographer" could hardly dispose of the land forms in less space than that, although he might substitute non-explanatory circumscription for the genetic accounts which Gradmann supplies. The second, regional, volume contains physical and human considerations in more intimate association. The section on the Neckarland, which Van Cleef selects as an illustration of the geomorphologic preoccupation of the author, has an equal number of pages on land forms and on human geography, and this ratio is typical of the whole volume.

The disregard of this large mass of "human" material, it appears, is to be explained because Gradmann just does not happen to be the reviewer's kind of human geographer. But the front-rank position which Gradmann has won in this very field is evident in the *Forschungen zur Deutschen Landes- und Volkskunde*, which he has made an unsurpassed and perhaps unequaled series of intensive studies in culture geography. And he has written largely, and many of us think most lucidly, on objectives and methods in human geography. Gradmann sees "life responses" as only a part of the problem, which is the harmonious analysis of geographic forms of culture, as expressed in their historical succession. The "environmentalist" may find slim picking in South Germany; but to the culture geographer it is a marvelously rich field, with its remarkable persistence of historic monuments. Stuttgart as an industrial and commercial city has very slender roots in the environment; as a study in urban evolution from a medieval background it becomes intelligible. It is none the less significant geographically to Gradmann because it is only in slight measure a "response to physical conditions." His "encyclopedism" is in fact a well-thought-out methodical basis which prevents the impoverishment of the subject to a few conclusions based on a single set of "influences."

Geographers who do not care to do physical geography have the right to limit themselves, although it is a bit queer that the environmentalists should care so little about the physical qualities of regions. But whence do they derive the authority to correct or even to read out of the party those who concern themselves also with the origin of land forms? To the majority of the world's geographers and to educated people generally the great geographers are men like W. M. Davis, Richthofen, Penck, and De Martonne whose work has lain exclusively or in major part in physical geography. A field is occupied by preëmption and cultivation, and on these terms there is no other field to which geographers have so valid a claim. The important question is whether the work is significant, well done, and opens up larger horizons. I am at a loss to understand this pernicious anemia that has seized upon some geographers, expressed in a weary shaking of the head at sight of a fellow student happily productive and in the monotonous, sepulchral query: "But is it geography?" Imagine geologists saying about their work: "The work is good, but is it geology?" or economists forever saying to themselves: "We must not look into this matter, for it might turn out to be history or political science!" Barbed wire fences may be necessary in elementary curricula, but the pursuit of knowledge cannot afford to frustrate itself by building fences about narrow plots of learning.

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